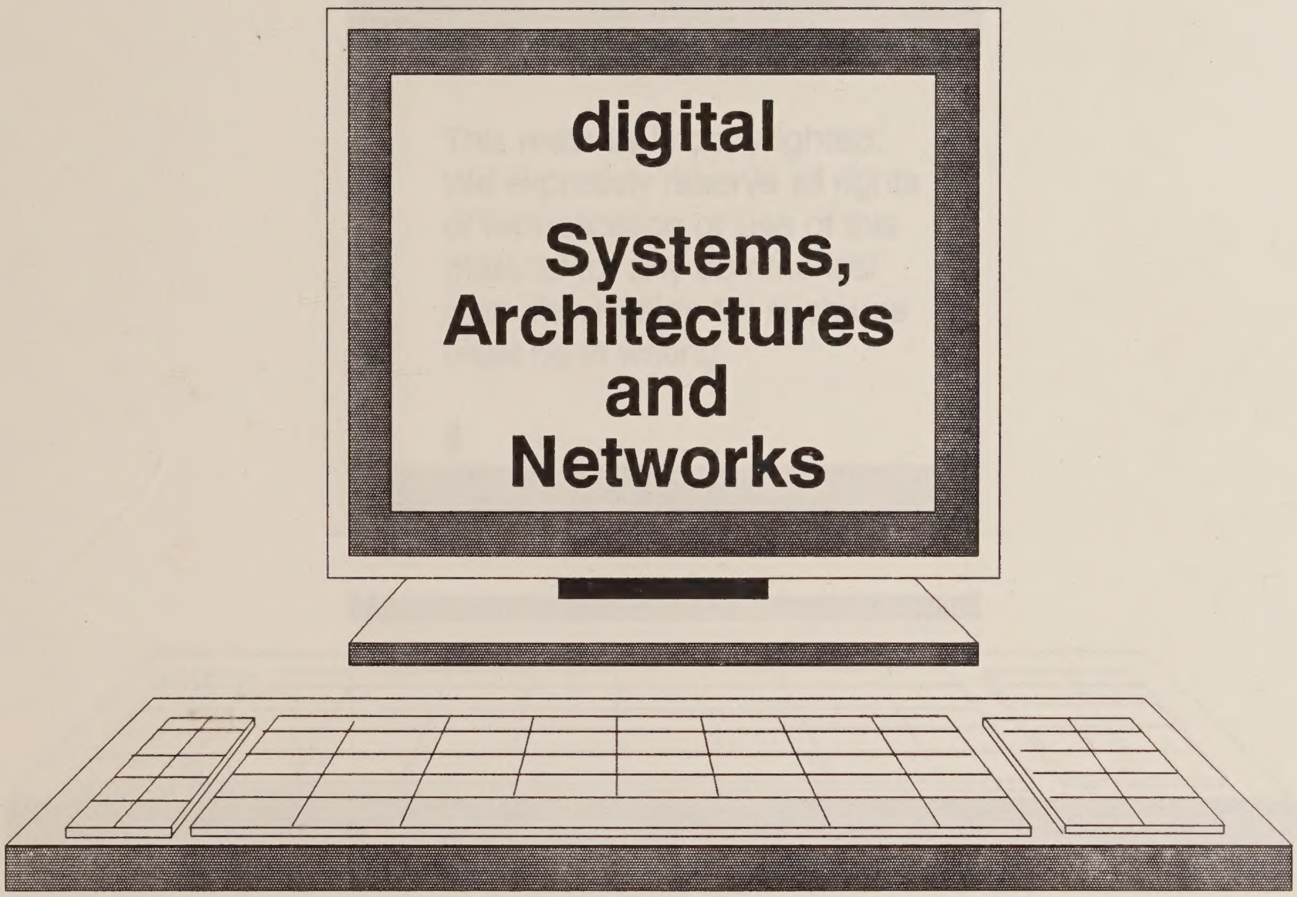

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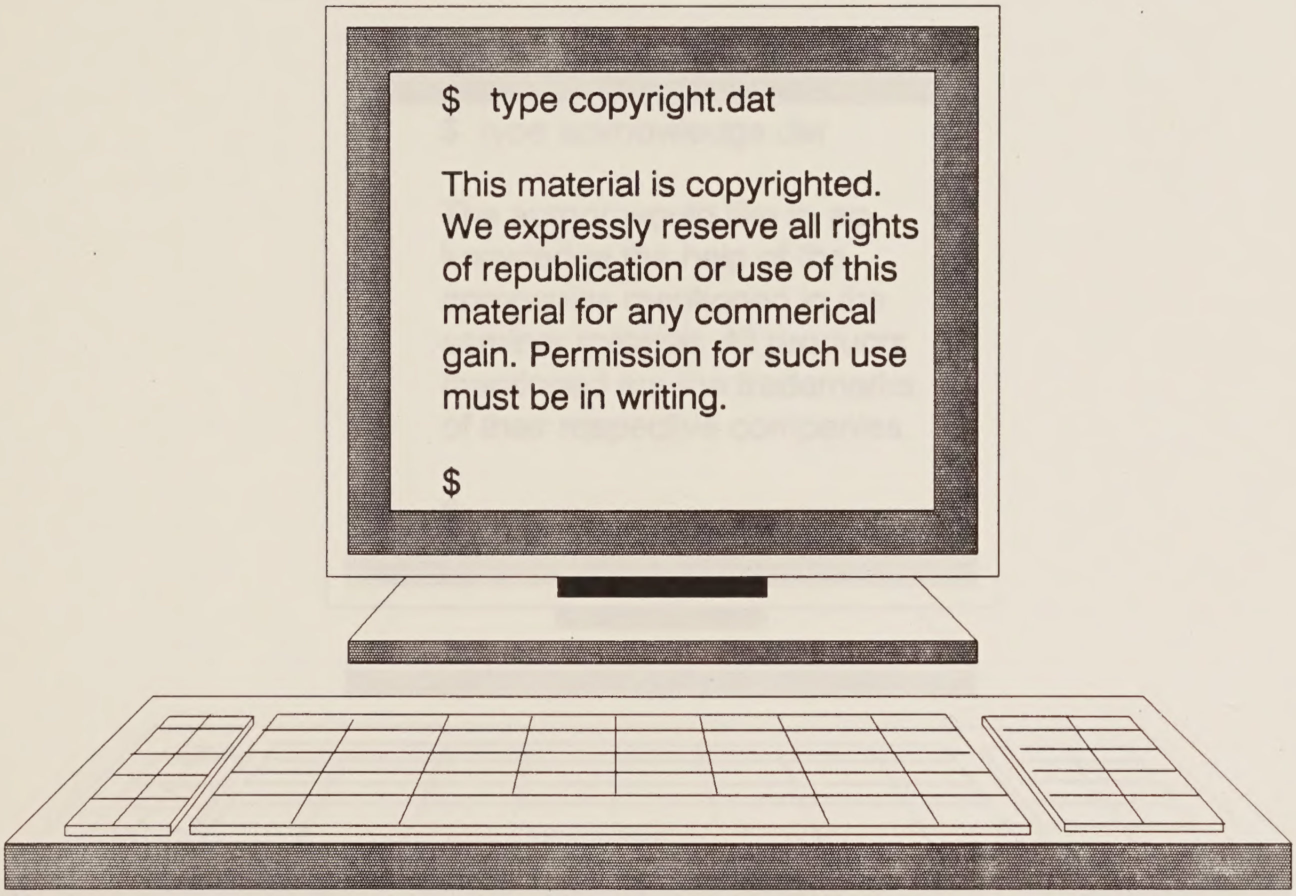
Systems, Architectures and Networks



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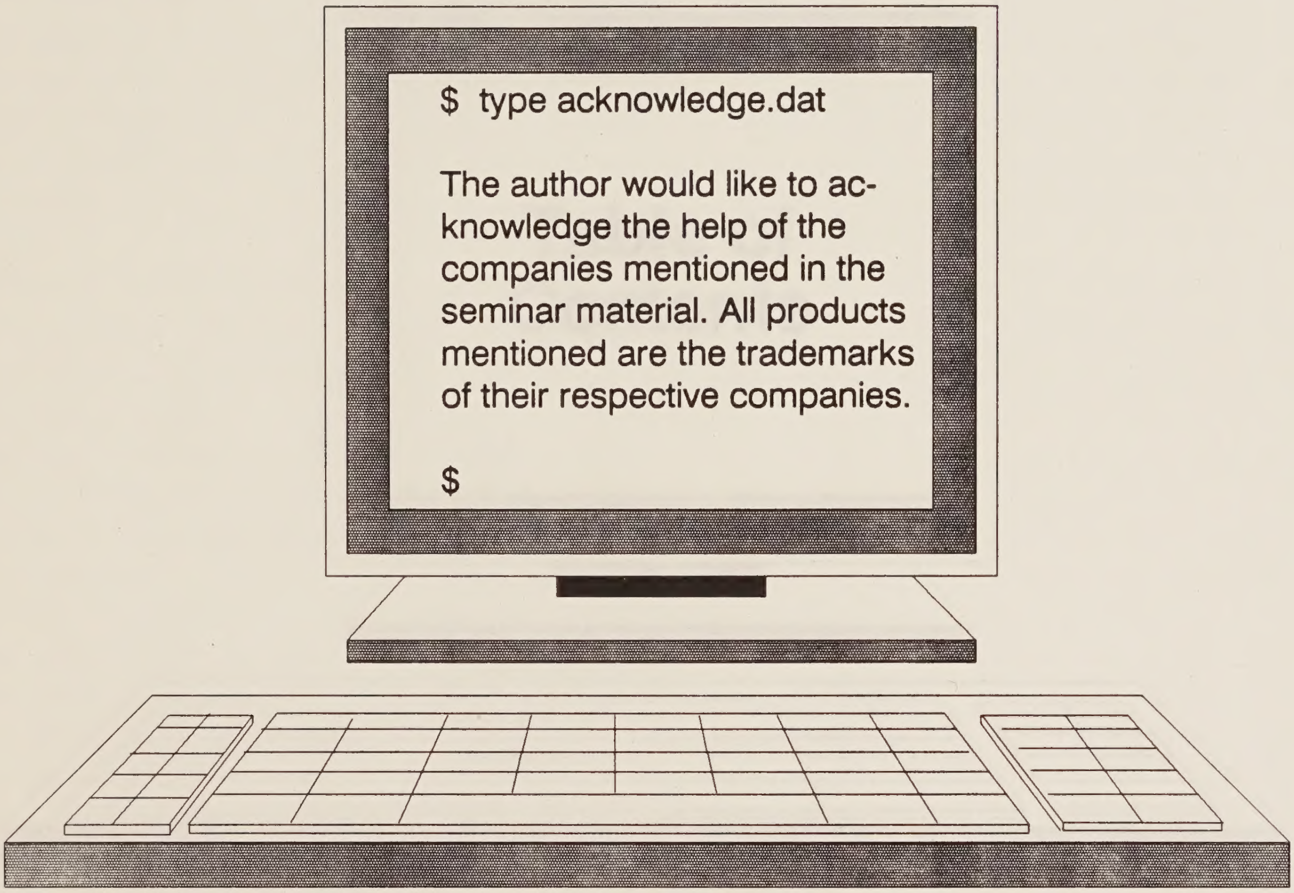

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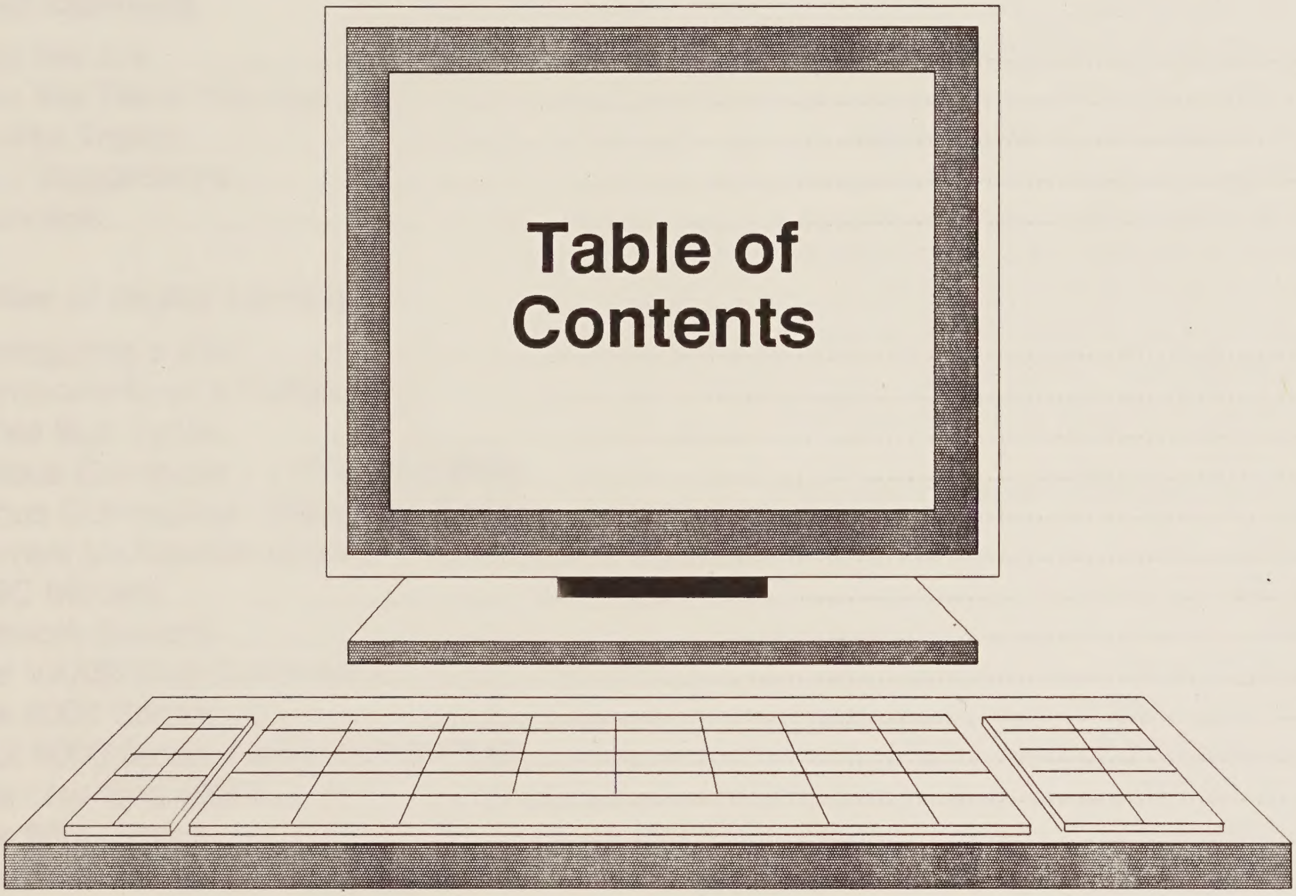

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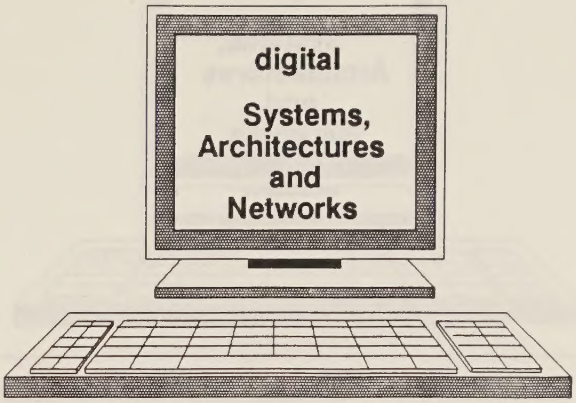

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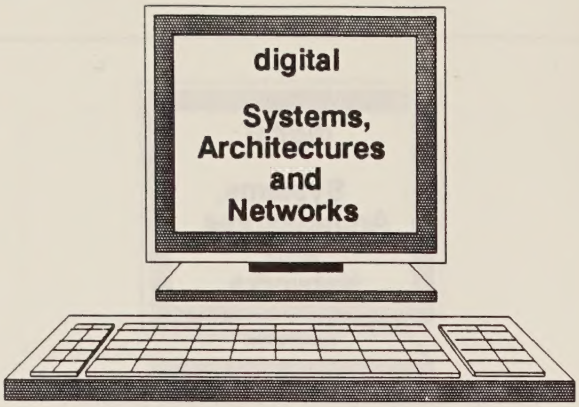

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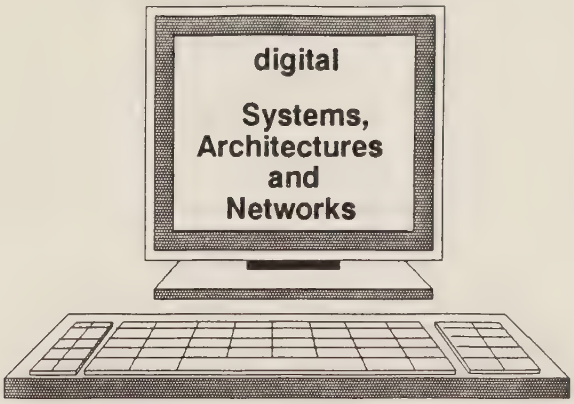

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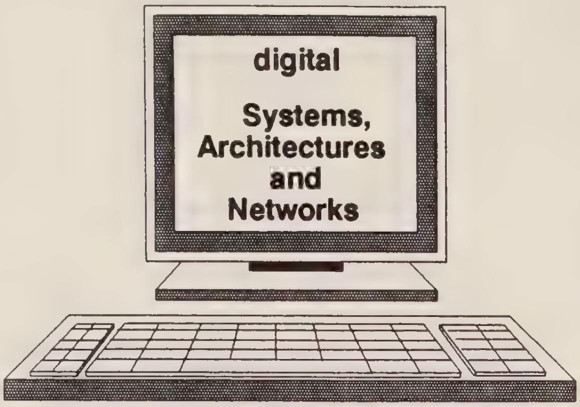

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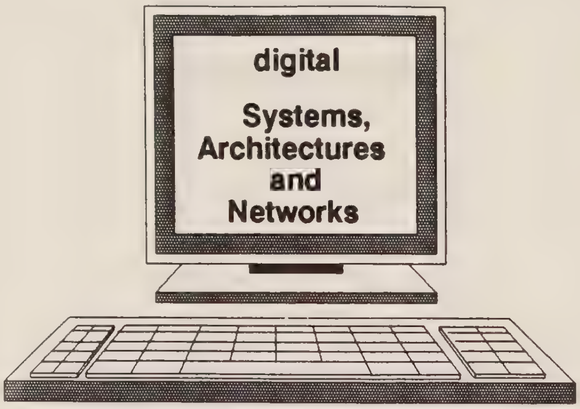

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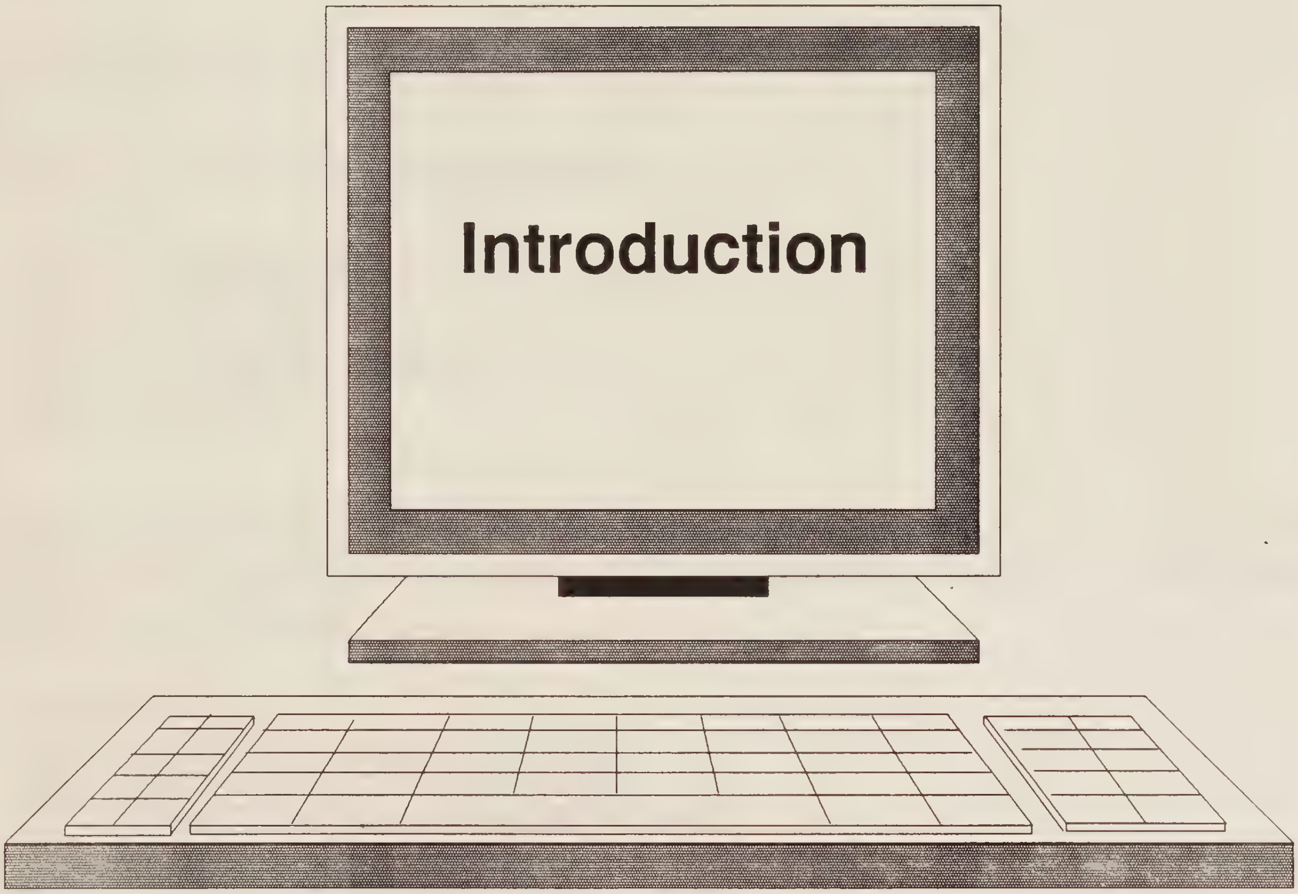
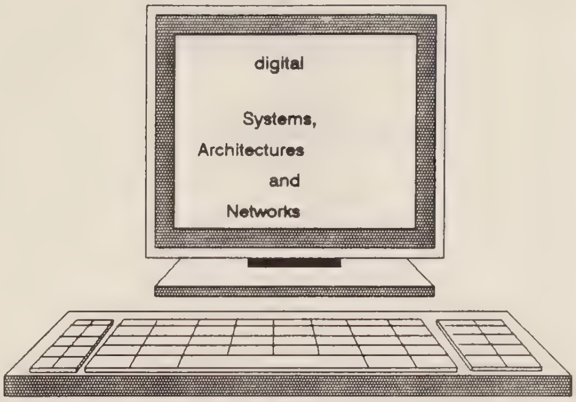


INTRODUCTION



Who We Are

- This seminar is sponsored by Gate Technology, Inc.
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  McLean, Virginia 22101
  (703) 790-5730

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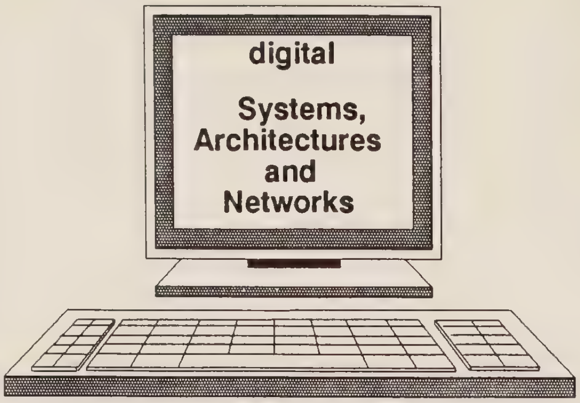
- If you have any questions about the course material, please feel free to contact Mr. Snellen.



INTRODUCTION

Who We Think You Are

- This seminar is aimed at those people wanting an in-depth overview of DEC products, systems and architectures. We designed the seminar with the following types of people in mind:

  > Technical personnel who have experience working on other vendor architectures and would like to find out about DEC.

  > End users on complex networks that want to understand how their system works.

  > Managers of DP who are interested in getting a broad view of DEC for planning purposes.

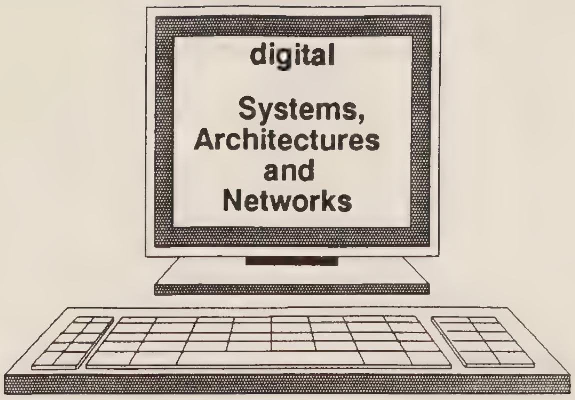
  > Managers or planners who have responsibility for automating the operations in their area (or who deal with those who do and want to understand what they're saying!).

  > Sales or marketing people in the computer industry.

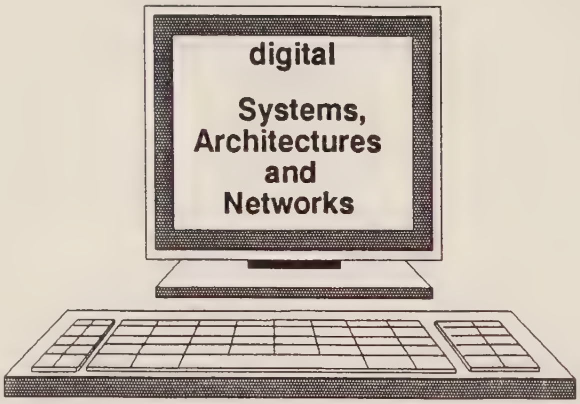
- The seminar is NOT a DEC sales pitch. The seminar leaders are persons who have extensive hands-on and consulting experience with DEC equipment.

- The topics in this seminar are technical in nature. We expect you to have a basic understanding of industry terminology. However, each topic will be introduced with the assumption that the topic is new to a majority of the class.

INTRODUCTION



- Course Topics
  - > Introduction
  - > Hardware
  - > VAX Operating Systems
  - > Clusters
  - > Digital Network Architecture
  - > Ethernet LAN, MAN & WAN Networks
  - > Wide Area Networks
  - > Software
  - > SNA
  - > TCP/IP
  - > OSI/DECnet Phase V

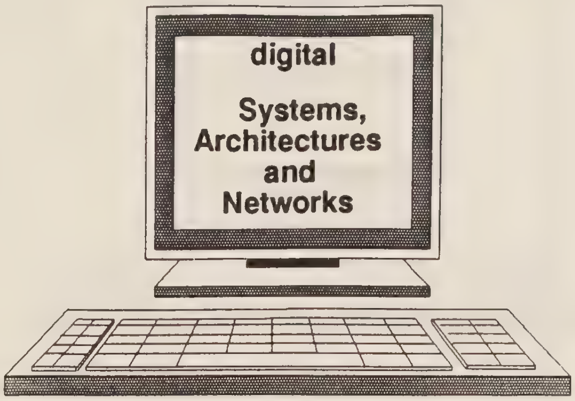


Your Suggestions

- You are one of the best sources of information on how products really work (as opposed to how they're supposed to work). Let us know if you've found specific products that don't work or you have new products that you're allowed to talk about.

- Nobody knows everything there is to know about every one of these topics. We've researched the topics thoroughly based on our own experience, in-depth examination of available DEC literature and by interviewing DEC specialists from a variety of areas.

- There are suggestion forms at the back of the book. PLEASE, if you think we're missing something - tell us.



Exercises

- You're going to get tired of hearing specifications and looking at hypothetical network topologies. We've included several exercises to give you a little hands-on experience as a network planner.

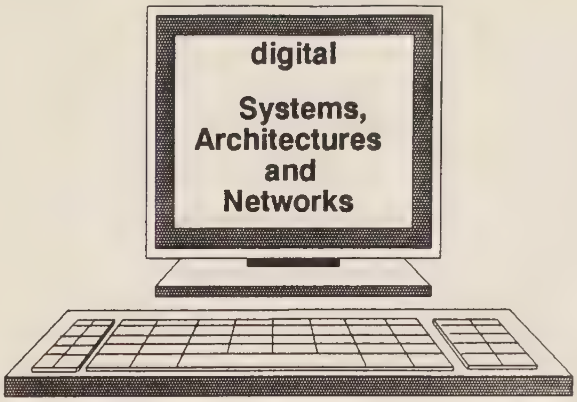
- The exercises are meant to identify possible options, NOT to arrive at a definitive solution. This means that you will be forced to make assumptions. If this were a real situation, you would then go back and do some research to determine the validity of those assumptions.

- For example, you might assume that 48 users on a DBMS system could get by on 24 MBytes of main memory. Further research would consist of analysis of the nature of the user applications, interviews with the vendor to determine the range of memory requirements and prediction of the numbers of simultaneous users at both average and peak times.

> **"The next best thing to knowing a fact is knowing where to find it."**
>
> *Author Unknown*

Digital Hardware Products

DIGITAL HARDWARE PRODUCTS



Overview

- Three kinds of VAXes
  - > Unibus (11/7XX Series)
  - > Q-bus (MicroVAX Series)
  - > VAXBI bus (8000, 6200, 6300 Series)
- Storage Architectures
- Other Peripherals: Terminals, Printers
- Future Directions

Configuring a VAX

- CPU

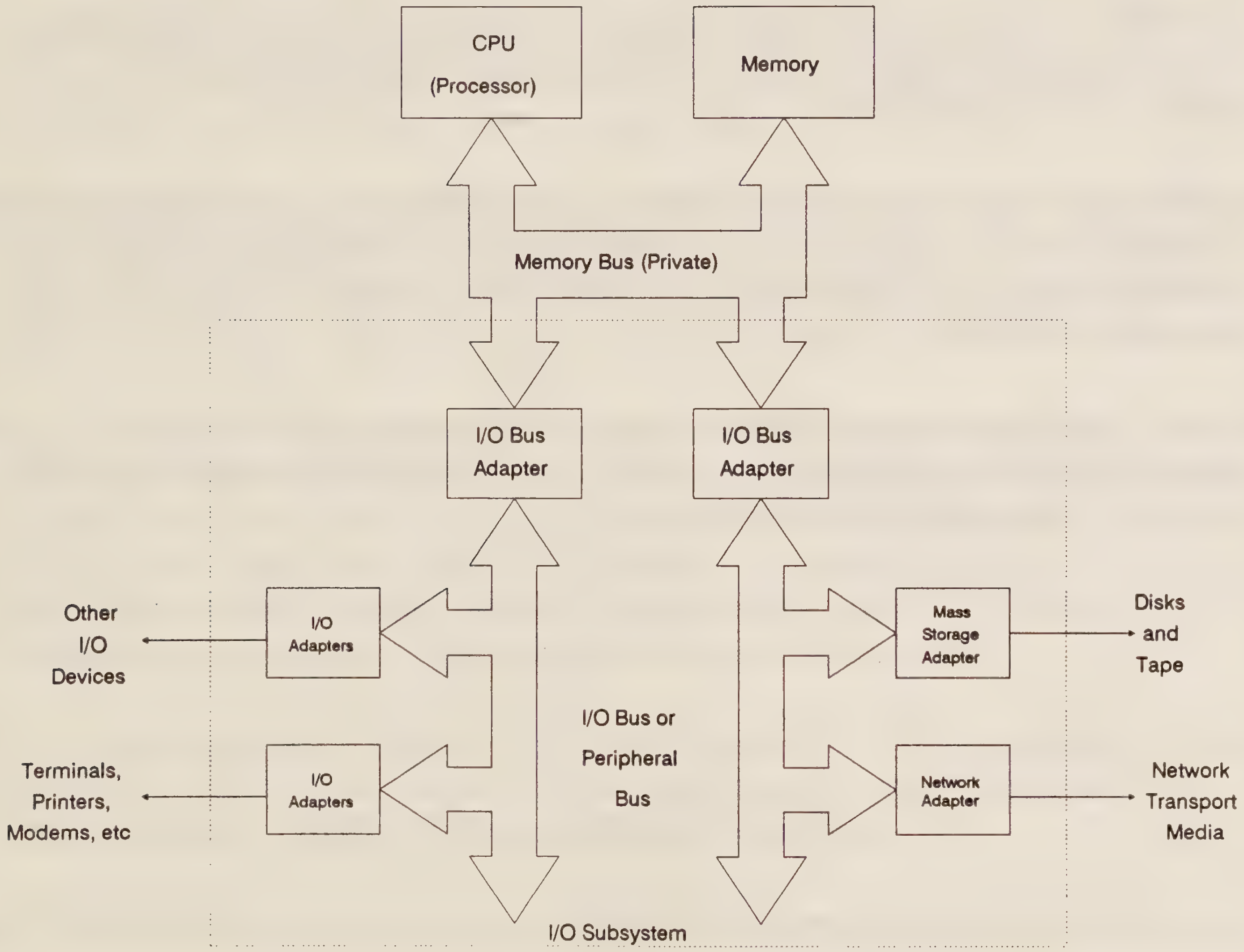
- Memory. Memory and the CPU communicate over a high speed private bus. In the case of the 8000 series, this private bus operates at 50 MBytes/s, in contrast to the public bus which operates at 13.3 MBytes/s.

- Peripheral Bus ("Public" Bus). Used to connect peripheral controller, such as disk drive controller, to the CPU. The VAXBI bus is an example of a peripheral bus. There may be several peripheral buses on a system - an 8800 can have up to 6 VAXBI buses.

- Device Controllers. Used to interface a peripheral, such as a disk drive, to the peripheral bus. A controller may have several devices on it. For example, a disk controller typically can accommodate 4 disk drives.

- Devices. Examples include terminals, printers, tape drives, disk drives and optical discs.

Components of a Computer

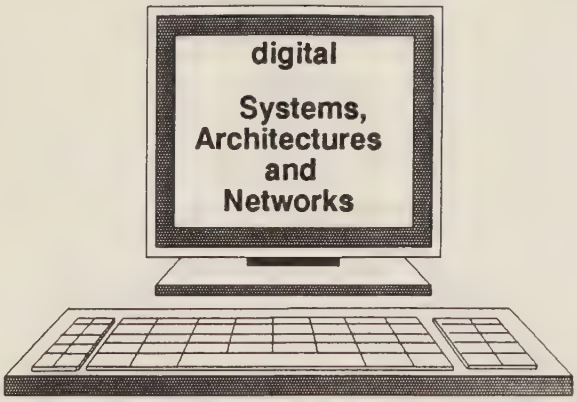


Three Bus Types

- Unibus. The Unibus operates in the 1-2 MBytes/s range. On old VAXes, this often resulted in bus saturation. There would be CPU cycles available, but needed data would still be in the pipeline from the disk drive to the main memory. Computers based on this bus are being phased out of production.

- VAXBI bus. The VAXBI bus operates at 13.3 MBytes/s. 2 VAXBI buses on a system result in an aggregate bandwidth of 16 MBytes/s, 4 VAXBI buses result in a 30 MBytes/s bandwidth. The "missing" bandwidth is for inter-bus arbitration.

- Q-bus. The Q-bus is a 22 bit bus, in contrast to the other two 32 bit buses. The bus comes from the (16 bit) PDP line of minicomputers and is used in all present MicroVAXes.



Unibus Computer - 11/7xx and 8600

- VUP = VAX Units of Processing. An 11/780 = 1 VUP.

- The 11/7xx series was introduced around 1980 but has been discontinued. The Unibus systems ranged in processing power from .2 VUPs with an 11/725 to 6 VUPs for the 8650.

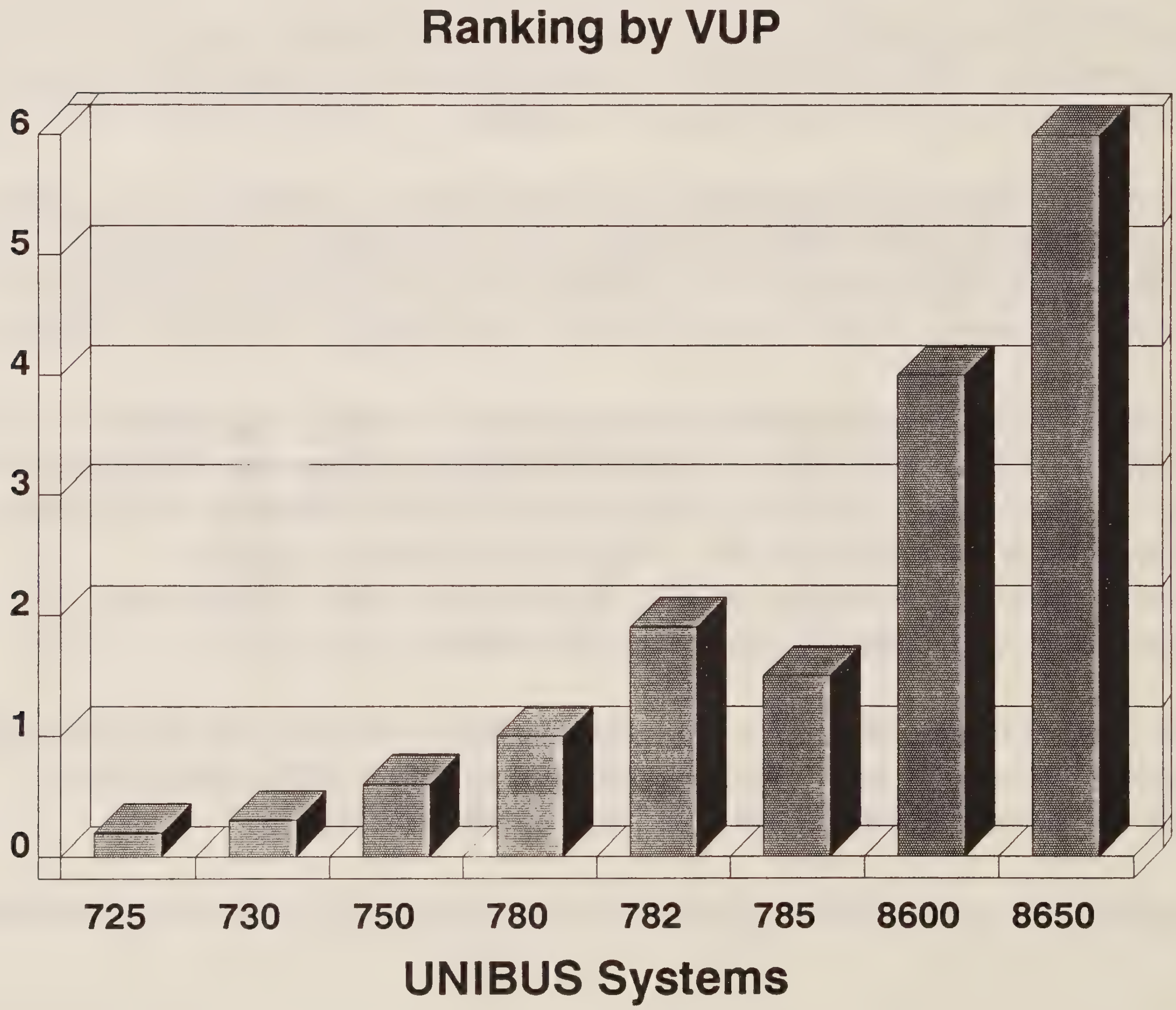
- The 11/780 has long been considered an industry standard. A huge third party market exists for Unibus peripherals. For example, although DEC would only support 8 (later 16) MBytes of main memory, third party vendor solutions could increase this to 128 MBytes.

- The 11/782 is a dual processor version of the 11/780. These are asymmetric dual processors: one CPU handles all the I/O, while the second CPU does only computational tasks. In an I/O-bound environment, upgrading to an 11/782 could actually result in performance degradation. (NOTE: Because the VAX 11/782 is an asymmetric computer, it cannot run VAX VMS 5.0 and up.)

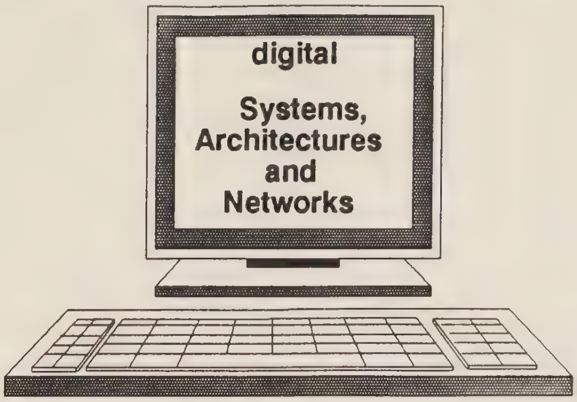
- The Unibus high-end series contains the 8600 (4 VUP) and 8650 (6 VUP). These are the only two remaining Unibus systems still in production. DEC will phase out the 8600 and 8650 by May 1989.

- A huge third party market has developed around the Unibus architecture.

Unibus VUP Comparison Chart



(11/780 = 1 VUP)

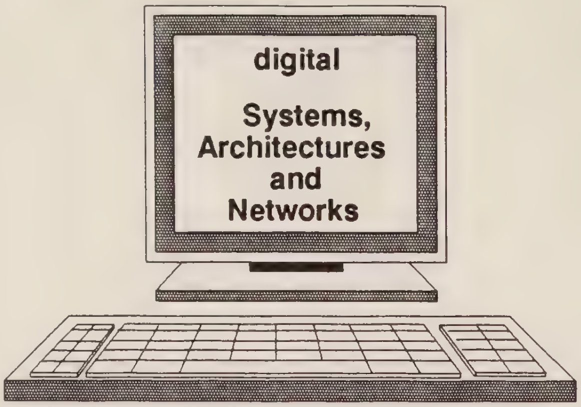


Q-bus Computers - MicroVAX Series

- MicroVAX (General Purpose). These MicroVAXes are configured as a multi-user, time-share VAX. This includes disk controllers and disk drives as well as asynchronous controllers and printers, terminals, modems, etc. Any of the MicroVAX computers can be used as a general purpose computer.

- MicroVAX (VAXstations). VAXstations are single-user workstations with a high resolution bit-mapped graphics display. VAXstations currently feature either 15- or 19-inch screens in monochrome or color. Typical applications are CAD/CAM, Desktop Publishing, and other graphics-intensive applications.

- MicroVAX (Network Server). A network server is often identical to other MicroVAX models. However, servers provide network-type services to other network clients. These services include high-capacity storage, boot service, network routing, remote queuing service, shared printers, and many others.



Current Timeshare MicroVAX Models

- MicroVAX 3100. A 2.4 VUP computer that replaces the MicroVAX 2000. Can have up to 1.5 GBytes of storage. Allows for 12 directly connected terminals. Can also be networked. This is the first DEC computer to support the Small Computer System Interface (SCSI). The entry level MicroVAX will cost about $8,480.

- MicroVAX 3300 and 3400. 2.5 VUP computers. Have a dual porting capability using the Digital Storage Systems Interconnect (DSSI) cable. Up to 6 RF71 ISE drives (2.4 GBytes) can be shared between two computers. Both machines have the storage adapter and Ethernet controller built onto the CPU board. Memory from 12 to 28 MBytes. An expansion cabinet is available.

  - The 3300 has 6 Q-bus slots available. U.S list price is $34,750. An entry level system with a one to five user license costs $25,000.

  - The 3400 has 12 Q-bus slots available. Has a U.S. list price of $45,750.

- Both EMC and DataRam Corporation offer memory upgrades for the 3300 and 3400. With EMC boards, you can have up to 64 MBytes of memory.

MicroVAX 3800 and 3900 Systems

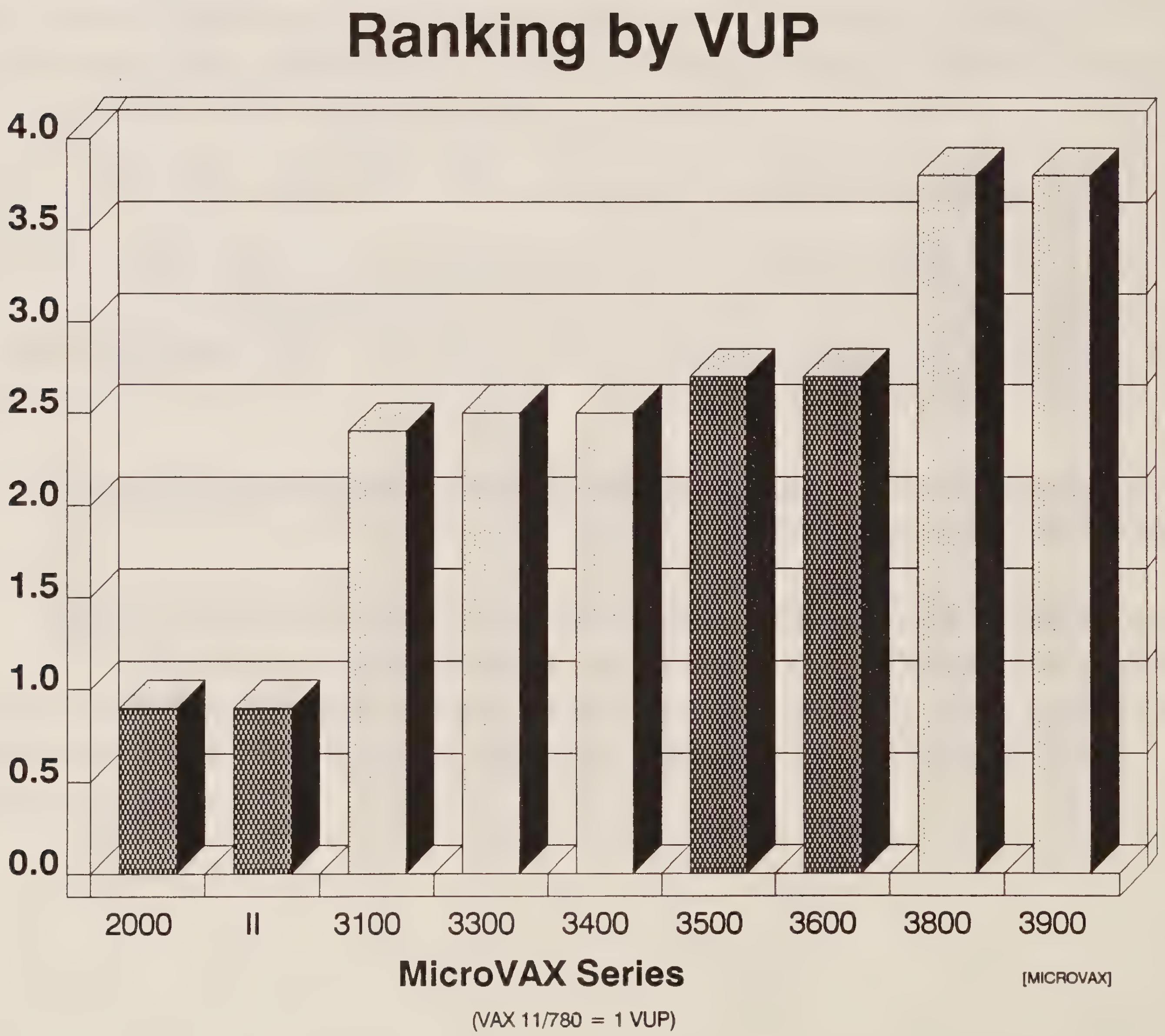
- MicroVAX 3800. Replaces the MicroVAX 3500. Offers one and one-half times the performance and four times the storage capacity of the MicroVAX 3500. Uses the DSSI bus to access the RF71 (400 MBytes) drives. Up to six RF71 drives are available (with expansion cabinet). Designed to operate in an office environment. Digital offers a custom 60-inch cabinet containing two MicroVAX 3800 systems in a dual-hosted configuration. Base memory is 16 MBytes. U.S. list price is $81,000.

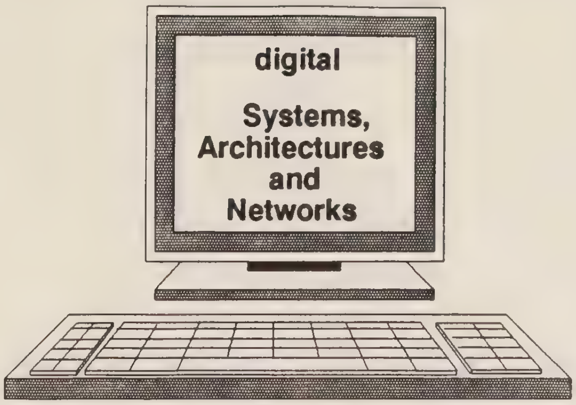
- MicroVAX 3900. Replaces the MicroVAX 3600. Has a built-in RA90 (1.2 GByte) disk drive. Can be expanded up to 9.7 GBytes. Base configuration is 32 MBytes memory, one RA90 drive and a 20 user VMS license. U.S. list price is $120,000.

- Both systems can be expanded to 64 MBytes memory and both use the 60 ns CVAX processor chip.

- DEC is offering an upgrade package for the MicroVAX 3500 and 3600 systems. For $20,000, you can convert to the higher performance machines.

MicroVAX VUP Comparison Chart





Current VAXstation Models

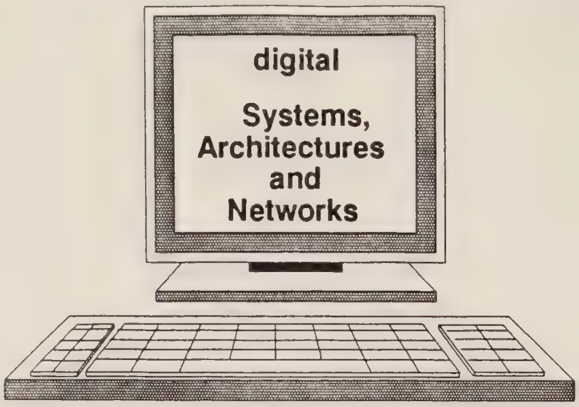
- All VAXstations run either VMS or Ultrix and may or may not have local disks.

- Each VAXstation is a complete system configured for one user. A VAXstation includes monitor, keyboard, mouse, memory, Ethernet controller, and printer/modem connections. Monitor choices are 15- or 19-inch, monochrome or color. Resolution is 1024 x 864.

- VAXstation 3100. CVAX CPU. Both models use the SCSI disk interface. models. Model 30 includes 208 MBytes (2-RZ23s) storage and up to 8 MBytes memory. Model 40 has 312 MBytes (3-RZ23s) storage and up to 16 MBytes of memory. Can run VAXpc, a MS-DOS emulation package.

- VAXstation 3200. CVAX CPU. 4 or 8 planes. Memory up to 16 MBytes. Local storage up to 318 MBytes.

- Third party solutions can be used to expand the memory in any of the VAXstations.



More VAXstations

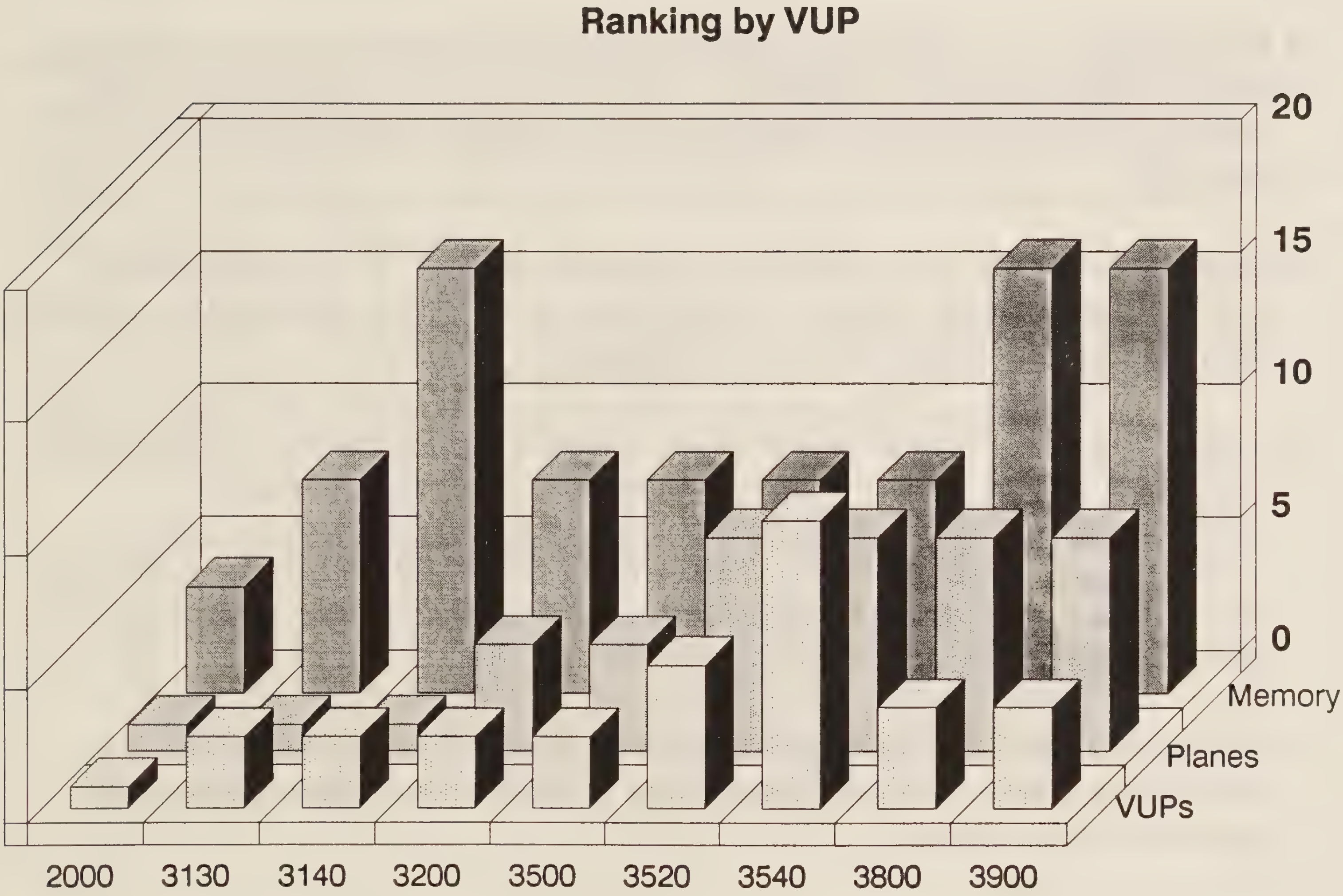
- **VAXstation 3500. CVAX CPU. 4 or 8 planes. Memory up to 32 MBytes. Local storage up to 560 MBytes.**

- **VAXstation 3520 and 3540. Uses dual CVAX CPUs on a single board. Is capable of symmetrical multi-processing (SMP). Employs a new M-bus with a bandwidth of 13.3 MBytes. A Q-bus adaptor is available. Memory up to 16 MBytes. Monitor resolution is 1280 x 1024. The 3540 has two dual CVAX CPU boards. The 3520 list for $23,950 while the 3540 will cost $43,950.**

- **VAXstation 3800. Uses the same architecture as the MicroVAX 3800. U.S. list price is $56,100.**

- **VAXstation 3900. U.S. list price is $84,900.**

VAXstation Comparison Chart



VAXstations

(VAX 11/780 = 1 VUP)

[VAXSTATI]

RISC Models

- DEC currently OEMs their RISC computers from the MIPS Computer Systems, Inc. Currently these models only run Ultrix-32. Both use the SCSI disk interface.

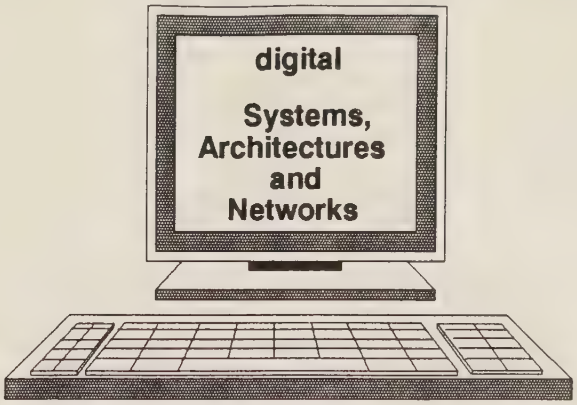
- DECstation 2100. Uses the MIPS R2000 CPU. Performance is about 10 VUPS. Memory from 8 MBytes to 24 MBytes. Local storage up to 406 MBytes with an expansion cabinet. Price ranges from $8,000 to over $10,000.

- DECstation 3100. Uses the same R2000 RISC chip as the DECstation 2100, but at a faster speed. Performance is 14 VUPs. Memory up to 24 MBytes. Local storage up to 332 MBytes.

- DEC also sells a time-share version called the DECsystem 3100. Can be used as a compute or file server. Purchase includes licenses for Ultrix-32, TCP/IP, NFS, DECwindows / X Window System and an optimizing C compiler. Prices range from $20,400 for a 4-user, 8MByte, 332 MByte disk system to $55,604 for a 32-user, 24 MByte memory and 996 MBytes of storage.

- The R2000 CPU will be upgraded to the R3000 CPU by Fall 1989. The R3000 has a reported performance of 20 VUPs and offers advanced graphics capabilities.

- MIPS stands for Microprocessor with Interlocking Pipeline Stages.



More RISC Models

- DEC has recently introduced two high RISC models, the DECsystem 5400 and the DECsystem 5800. Both models are very usable for timeshare computing.

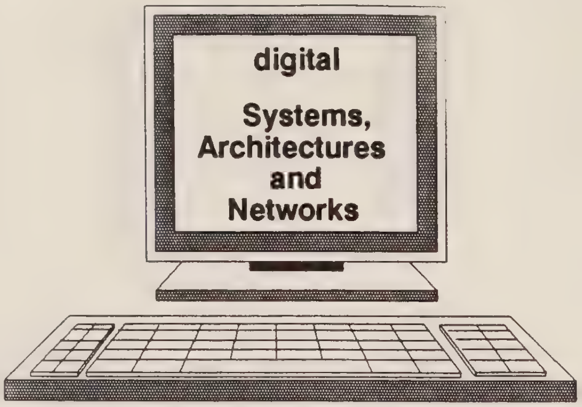
- The DECsystem 5400 can have 16 to 32 MBytes of memory. Storage options range from a diskless system up to 2 RA90 (2.4 GBytes) in a separate cabinet. A DSSI adaptor is available. List price varies from $35,275 for a diskless system to $181,700 for a 32 MBytes of memory and 2.4 GBytes of storage.

IO
Bus?
CPU?

- The DECsystem 5800 comes in two favors. Both come with a 16 user and UWS server license. Storage options include a diskless version, two built-in SA70 (560 MBytes) or a SA600 cabinet with two RA90s (2.4 GBytes).

  > The 5810 has 32 MBytes of memory. With two SA70 drives, the 5810 will list for $121,500.

  > The 5820 has 64 MBytes of memory. With two RA90 drives, the 5820 will list for $228,700.



Network Servers

- Generally used to offload specialized tasks like file serving, network boot node, compute intensive tasks, print service, network routing, PC LAN, etc. VAXservers are intended to be dedicated servers and do not permit multiple, simultaneous login sessions.
- VAXserver 2000. A basis for the PC LAN server.
- VAXserver 3100. 16 MBytes memory. 332 MBytes RZ55 drive. $6,680.
- VAXserver 3500. 16 MBytes memory. 280 MBytes RA70 drive. $52,300.
- VAXserver 3600. 16 MBytes memory. 622 MBytes RA82 drive. $69,300.
- VAXserver 3800. 16 MBytes memory. 400 MByte RF71 drive. $56,100.
- VAXserver 3900. 32 MBytes memory. 1.2 GByte RA90 drive. $84,000.
- DECsystem 3100. Made by MIPS Computer Systems. OEM by Digital. Uses a R2000 RISC processor. Has a significant performance advantage over other servers. Runs only Ultrix-32.

The VAXBI Bus Computers

- The 6000 series uses an advanced CVAX CPU. This series offers up to 6 CPUs on a single high speed memory bus. Performance varies from 2.8 VUPs to over 40 VUPs.

- The 8000 series can be viewed as two groups: the low-end series and the high-end series. The low-end computers are being discontinued. The high-end computers are the Symmetric Multi-Processor (SMP) series. The 8800 series use a 45 ns ECL Gate Array CPU.

- The VAX 8974 and 8978 systems are prepackaged VAXcluster systems.

The 6000 Series

- DEC recently renamed the entire VAX 6000 series computers. They are now called VAX 6000-xxx. The VAX 6000 replaces the VAX 8xxx series.

- The VAX 6000-210 is an entry level system based on the VAX 6210. The Model 210 replaces the discontinued VAX 8200 and 8300 series computers. The Model 210 is available only in a single CPU configuration. Performance is about 2.8 VUPs. It has only one VAXBI bus port. Upgrading to a VAX 6000-410 will cost you $140,000. List price for the VAX 6000-210 is $129,000.

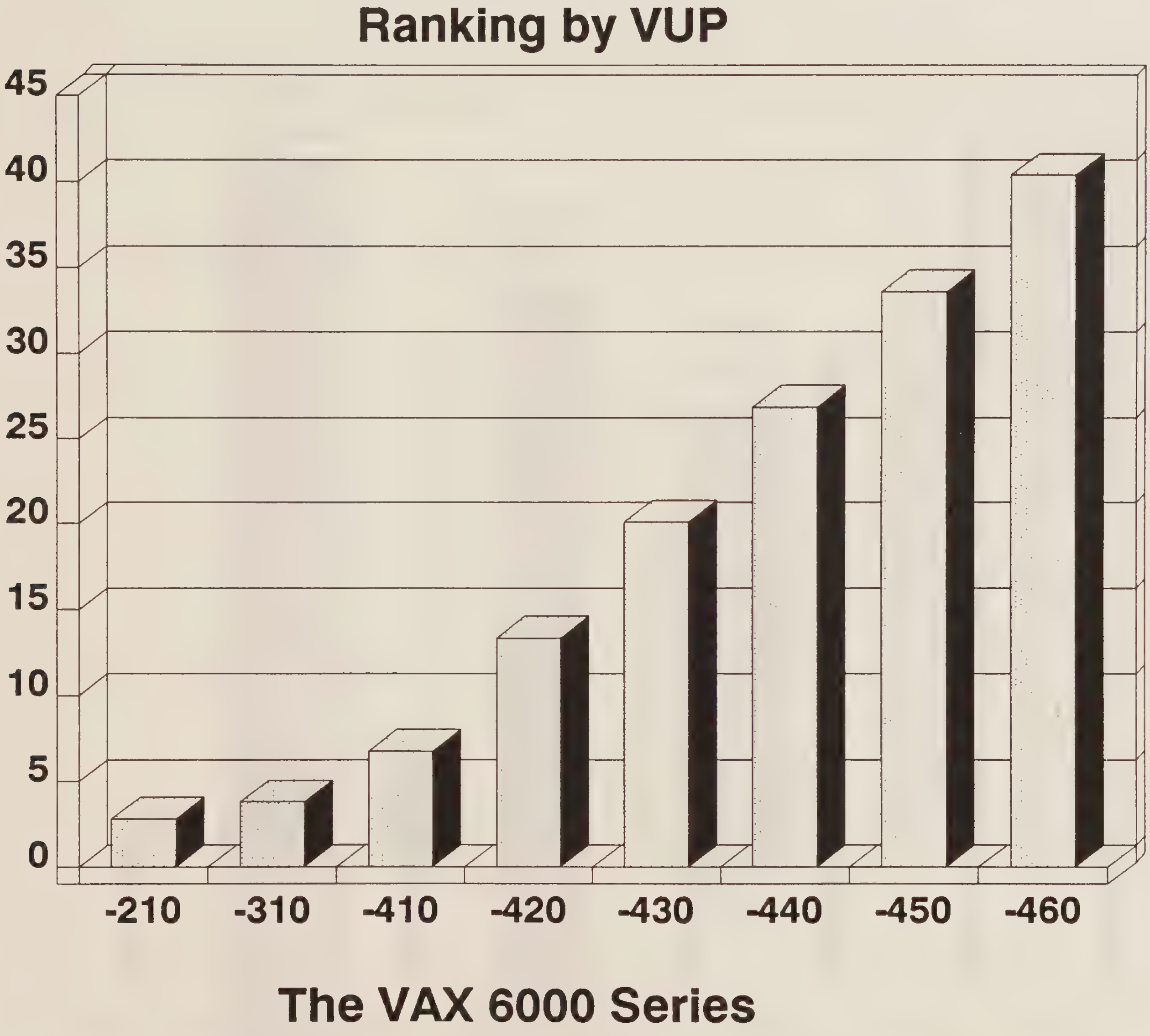
- The VAX 6000-310 is also a single CPU computer. It is based on the VAX 6310. Performance is 3.8 VUPs. Upgrading to a VAX 6000-410 will cost $84,000.

- The VAX 6000-4xx series were introduced by DEC in July 1989. This series has six models. The Model 410 is a single CPU computer while the Model 460 has six CPUs. The Model 410 has a performance rating of 7.7 VUPs. The Model 460 has a performance rating of around 46 VUPs.

- The VAX 6000-4xx can have up to six VAXBI buses (requires an expansion cabinet). The private bus is the Extended Memory Interconnect (XMI) bus which operates at 100 MBytes/s.

- Each CPU in the VAX 6000 series has a two tier memory cache. Tier one is 1 KByte (60 ns). Tier two is 256 KBytes (120 ns).

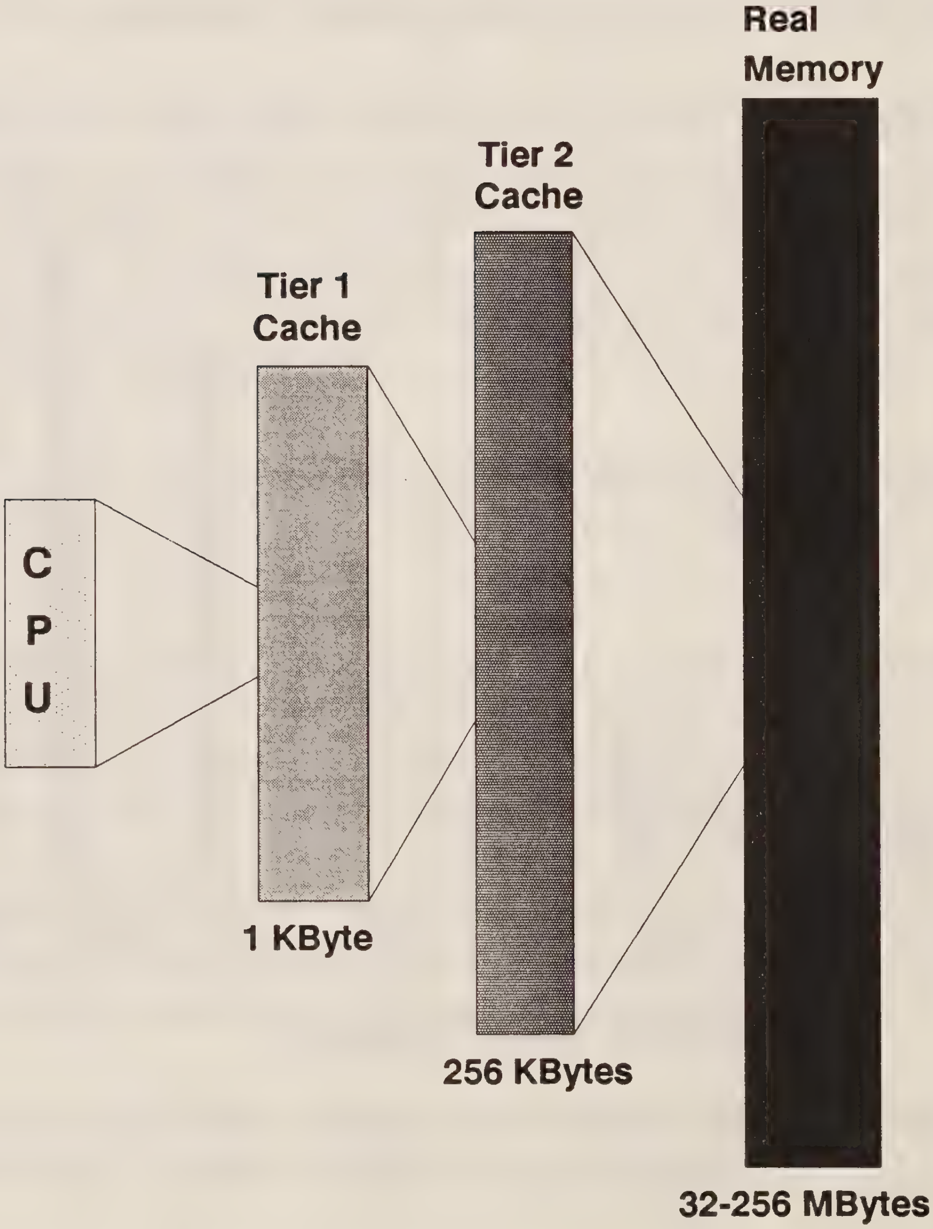
VAX 6000 Series Performance Chart



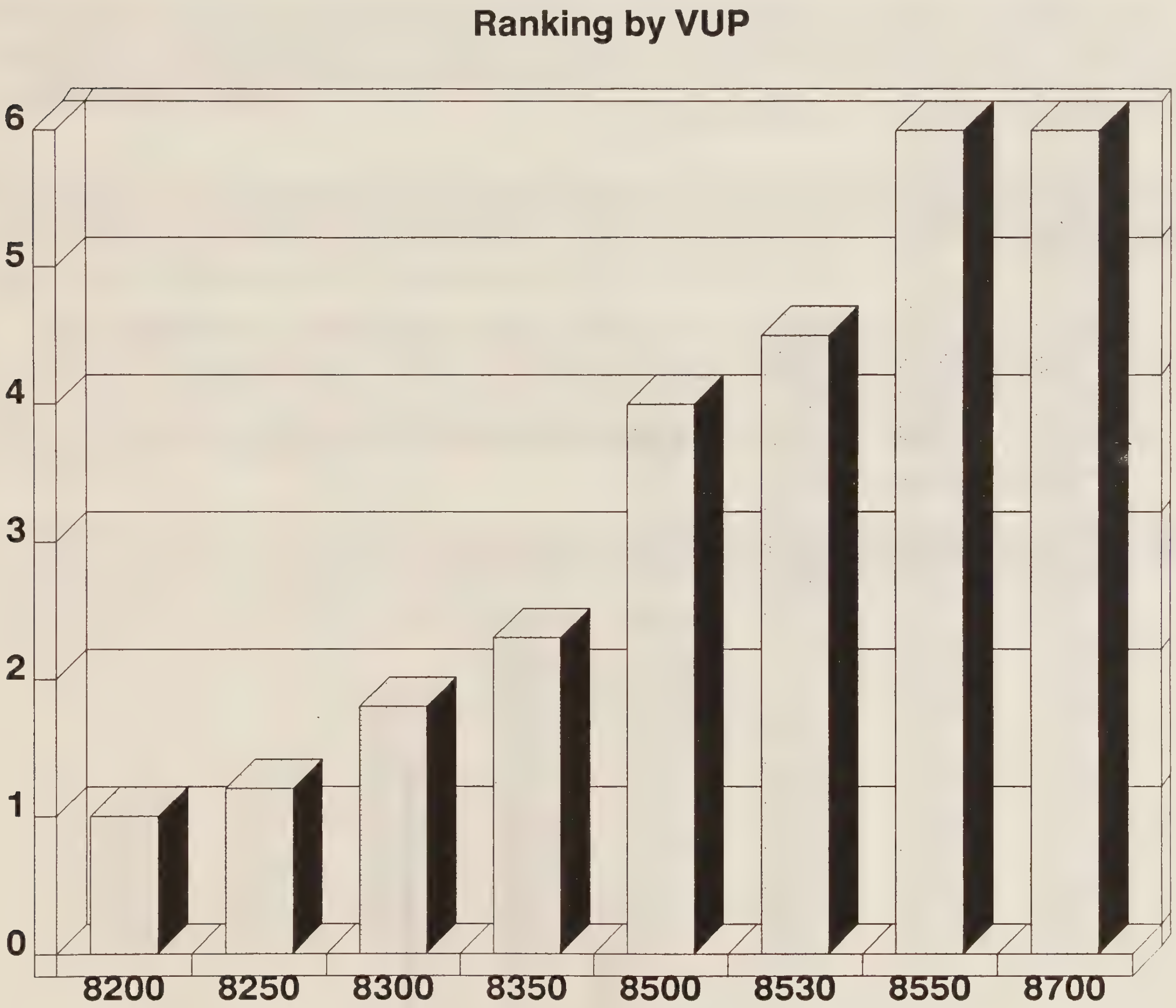
(VAX 11/780 = 1 VUP)

[VAX6000]

VAX 6000 Memory Cache



The Low-End 8000s



Ranking by VUP

(VAX 11/780 = 1 VUP)

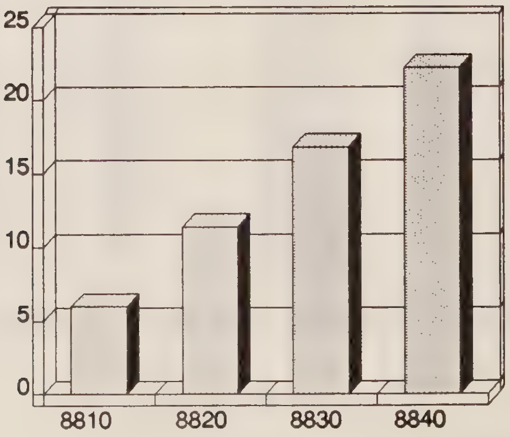
The 8800 Series

- In 1988 DEC unveiled a series of products which support Symmetric Multi-Processing (SMP). SMP systems support peer-to-peer parallel processing with shared memory.

- The first hardware systems to support SMP were the 8800 processors ("Polarstar").
  - > The 8810 has one CPU. The 8820 has two CPUs. The 8830 has three CPUs. The 8840 has four CPUs.
  - > Up to 6 VAXBI buses are available with 512 MBytes of main memory on an 8840.

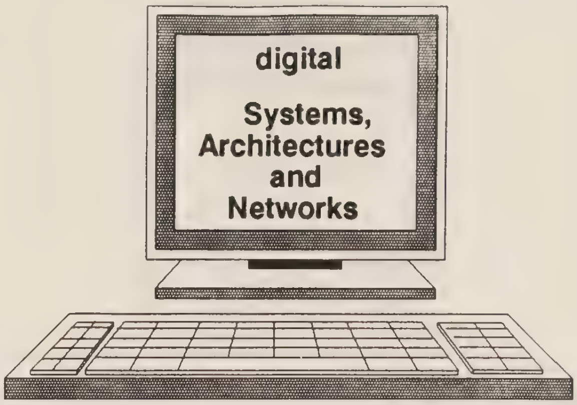
- The VAX 8800 series has been discontinued by DEC.

Ranking by VUP



VAX 8800 Series

(VAX 11/780 = 1 VUP)



The 8900 Series

- The 8974 and 8978 are DEC's very high-end systems. These systems are a prepackaging of existing technology. Because the systems are clustered, the user views a 8974 or 8978 as a single computer with enormous power.

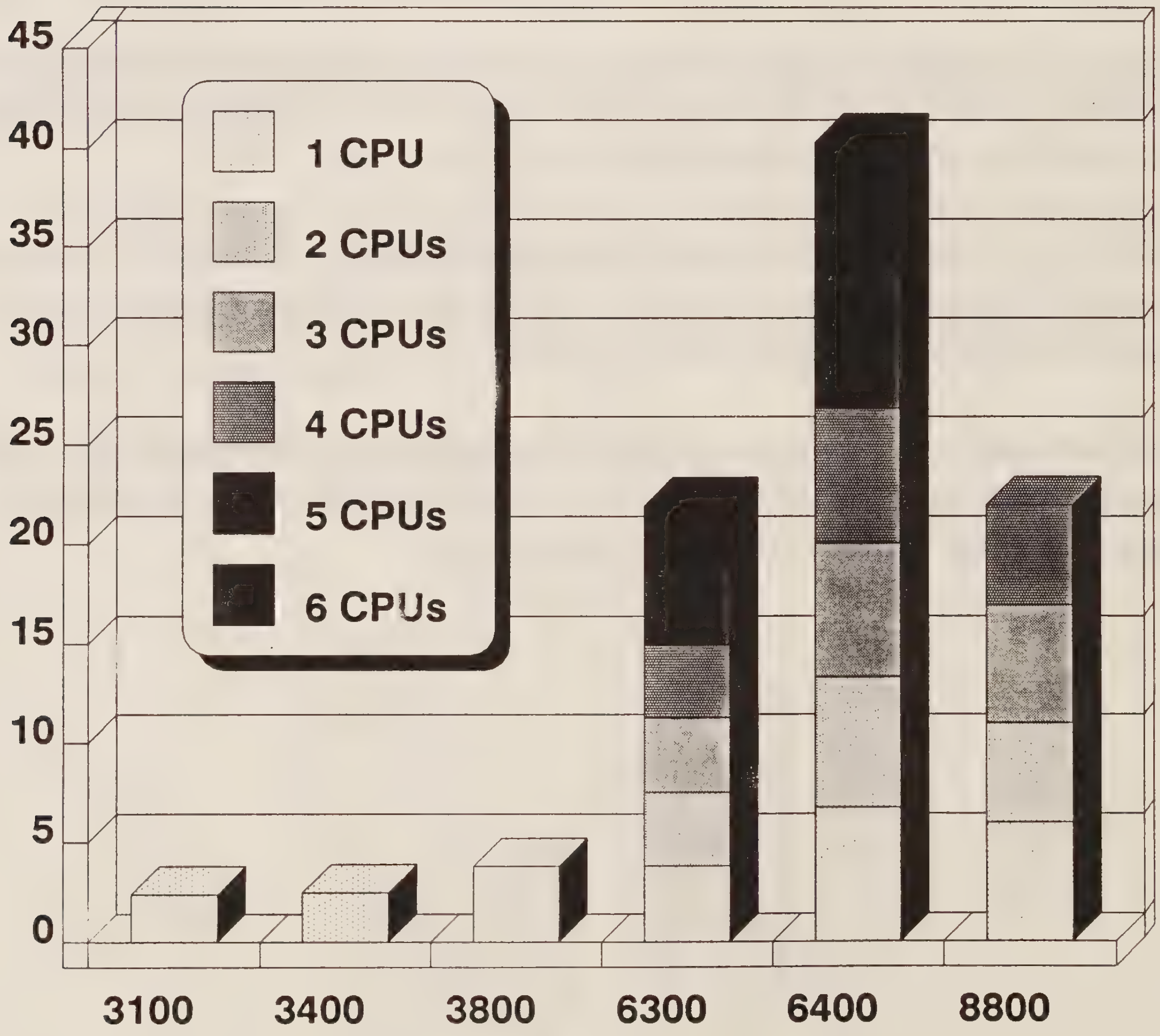
- The 8974 is a cluster of four 8810 processors, two HSC70 intelligent I/O processors, one SA482 Storage Array, and one TA79 tape drive. Memory up to 2.04 GBytes. DEC rates the 8974 at 24 VUPs.

- The 8978 is a cluster of eight 8810 systems, four HSC70 I/O processors, two SA482 Storage Arrays, and two TA79 tape drives. Memory up to 4.09 GBytes. DEC rates the 8978 at 48 VUPS.

- With either system, you have room for expansion. For example, the 8810 computers can be upgraded to 8820 or 8830 computers. Available storage can also be significantly increased.

DEC's Current Product Line

Ranking by VUP



(VAX 11/780 = 1 VUP)

[CURRENT]

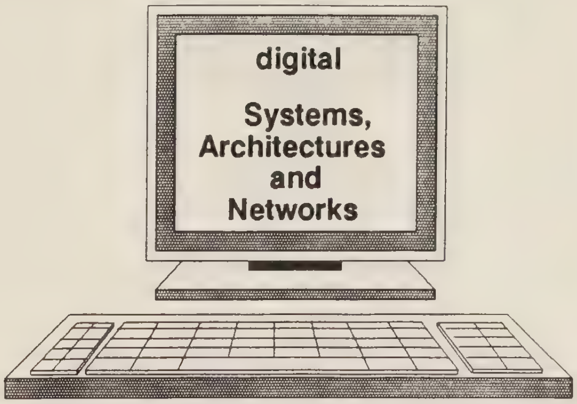
Estimate of VAX Performance

- This chart is a ROUGH estimate of user load. OLTP is On-Line Transaction Processing using ACMS. T/S is Time Share. The following understatement applies: "Actual number of users (processes) supported WILL vary depending on user applications."

	Number of users		
	All-In-1	OLTP	T/S
MicroVAX 3100	57	92	76
MicroVAX 3500/3600	60	96	80
MicroVAX 3800/3900	76	135	113
VAX 6000-210	64	115	85
VAX 6000-310	88	156	116
VAX 6000-410	155	277	206
VAX 6000-420	307	548	407
VAX 6000-430	465	825	614
VAX 6000-440	621	1103	820
VAX 6000-450	777	1379	1026
VAX 6000-460	933	1656	1232
VAX 8810	135	240	180
VAX 8820	240	430	325
VAX 8830	350	620	465
VAX 8840	465	810	610

Other Computers

- **Attached Processors**
- **PCs**
- **PDP 16-bit systems**



Attached Processors

- Instead of adding a new computer or attaching the VAX to a network with a supercomputer or database machine, you can add specialized boards that increase performance for specific tasks.

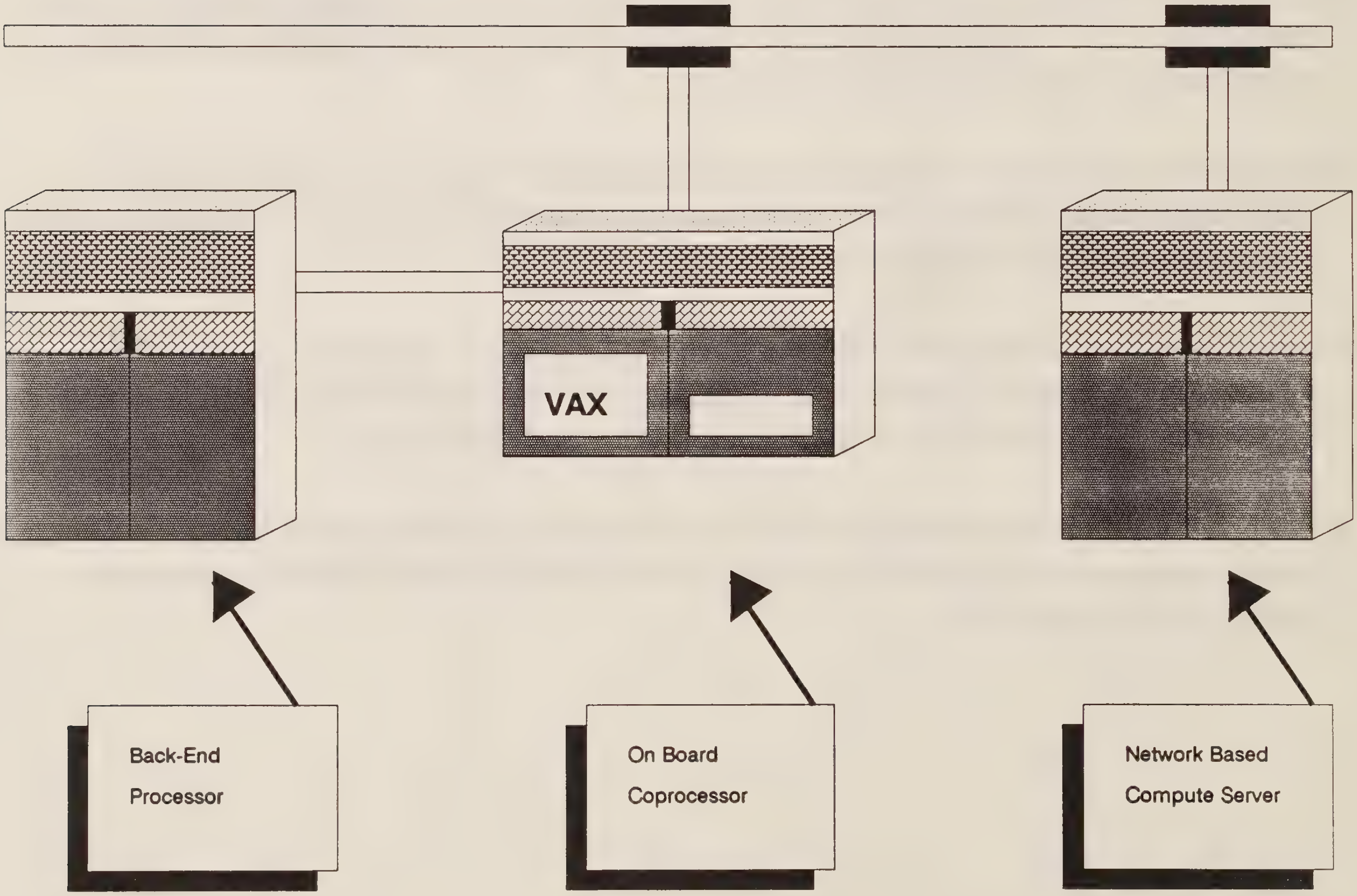
- Numerix makes the NMX-432 attached processor for mathematical computations. The processor can be an array or scalar processor with a maximum performance of 30 Mflops.

- Attached processors typically require that you recompile your code to take advantage of the array processing capabilities. Some vendors have compilers which do this automatically.

- An alternative is the new "cheap" supercomputers made by groups like Alliant and Convex. These machines can be attached to the VAX and are especially good for CPU-intensive Fortran applications.

- Sequent has an excellent 24 CPU machine that can be used as a database server. It runs Unix and be connected to an Ethernet network using TCP/IP and NFS.

Connecting Attached Processors



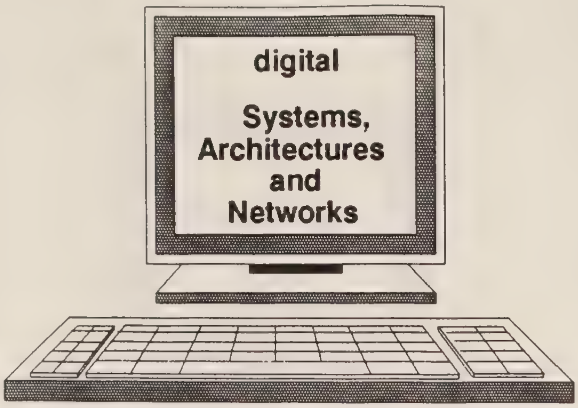
Back-End
Processor

On Board
Coprocessor

Network Based
Compute Server

ELXSI Parallel Processors

- ELXSI makes a parallel processor, the 6460, which offers 250 VUPs, 100Mflops, and 10 MBytes cache. Costs $4 million.
- The hardware architecture is based around a 320 MBytes/s bus. Maximum memory is 2 GBytes.
- The underlying operating system is called EMBOS. On top of that, you can run Unix System V, 4.2 BSD or EMS, a VMS emulator. You can have different operating systems running simultaneously, each one on a different processor but sharing resources.
- EMS includes emulation of Digital Command Language, an EDT-compatible editor, a VMS-compatible Fortran compiler and most of the VMS runtime system calls.
- The ELXSI can function as a Phase IV end node on a DECnet network. A peripheral interface controller can allow direct connection to a VAX using either HASP or UUCP.



PCs

- DEC makes the VAXmate, an 80286 (8 MHz) based system (like the PC/AT). The system has a built-in Ethernet board and a VT-style keyboard option.

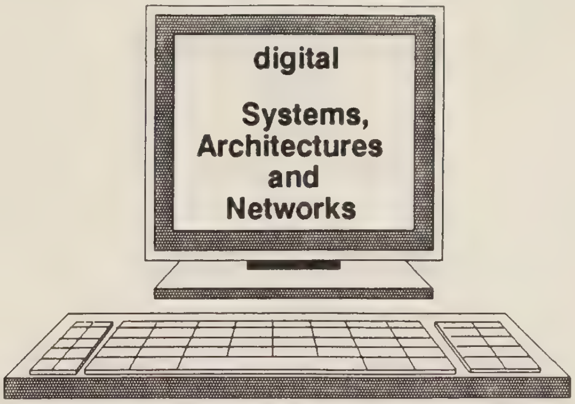
- Digital currently OEMs three PC-type computers made by the Tandy Corporation of Fort Worth, Texas. DEC has enhanced the computers with Ethernet controllers and PC integration packages.

- All three computers have standard PC features like VGA monitors, 3.5- or 5.25-inch floppy drives, 40 MByte hard drive and use MS-DOS 3.3. Standard PC upgrades are also available. For example, SCSI adapters, math co-processor, memory , etc.

  > DECstation 210. Uses the Intel 80286 (10 MHz). Has 640 KBytes RAM.

  > DECstation 316. Uses Intel 80386 (16 MHz). Has 1 MByte RAM.

  > DECstation 320. Uses Intel 80386 (20 MHz). Has 2 Mbytes RAM.



PDP-11 Systems

- The DEC PDP line of computers was extremely successful. Many of the original computers are still in use today. The MicroPDP-11 uses a Q-bus, while the PDP-11 computer uses the Unibus.

- The PDP-11 systems are general purpose, multi-user type systems. However, their power is so low compared to a PC's, that few users employ PDP-11s as general purpose computers.

- DEC is gently pushing PDP-11 users to upgrade to the MicroVAX series by offering upgrade kits. The migration path is PDP-11 to MicroPDP-11 to MicroVAX.

- Today, PDP-11 computers are used primarily for process control applications. For example, controlling robots, drilling machines, manufacturing applications, sensors, simulation, and other real-time applications.

Storage Peripherals

- DSA Architecture
  - > Controllers
  - > Drives
  - > Disk Clusters
- Other Architectures
  - > Storage Module Device (SMD)
- Other Storage Peripherals
  - > Tape Drives
  - > Tape Cartridges
  - > CD-ROM and WORM Optical Disc

Digital Storage Architecture

- Architecture for mass-storage products and intelligent controllers.
- Transfer disk management from the host CPU to an intelligent, high-speed controller.
- Seek ordering - reorders I/O requests to provide better use of disk.
- Overlapped seeking - can transfer from one disk while simultaneously seeking on another disk.
- Express queues - immediate servicing of requests.
- Disk block header information stored four times for efficiency and redundancy.
- Buffers - smooths high disk data burst rates to CPU.
- Error reporting and detection. 170 bit error correction code. Checks for media degradation, data-path errors, controller memory errors, Error Correcting Code (ECC) hardware operation errors.

DSA Compatible Controllers

- There are two types of DSA Controllers. The high-performance, stand-alone HSC I/O server and the board level controllers.

- The Hierarchical Storage Controller is used only in cluster environments. This is a stand-alone system with a PDP-11 based microprocessor and several high-speed microprocessors.

    > Offloads all disk management functions from host systems.

    > Internal data bus of 13.3 MBytes/s. Disk data-channel bandwidth of 3.125 MBytes/s.

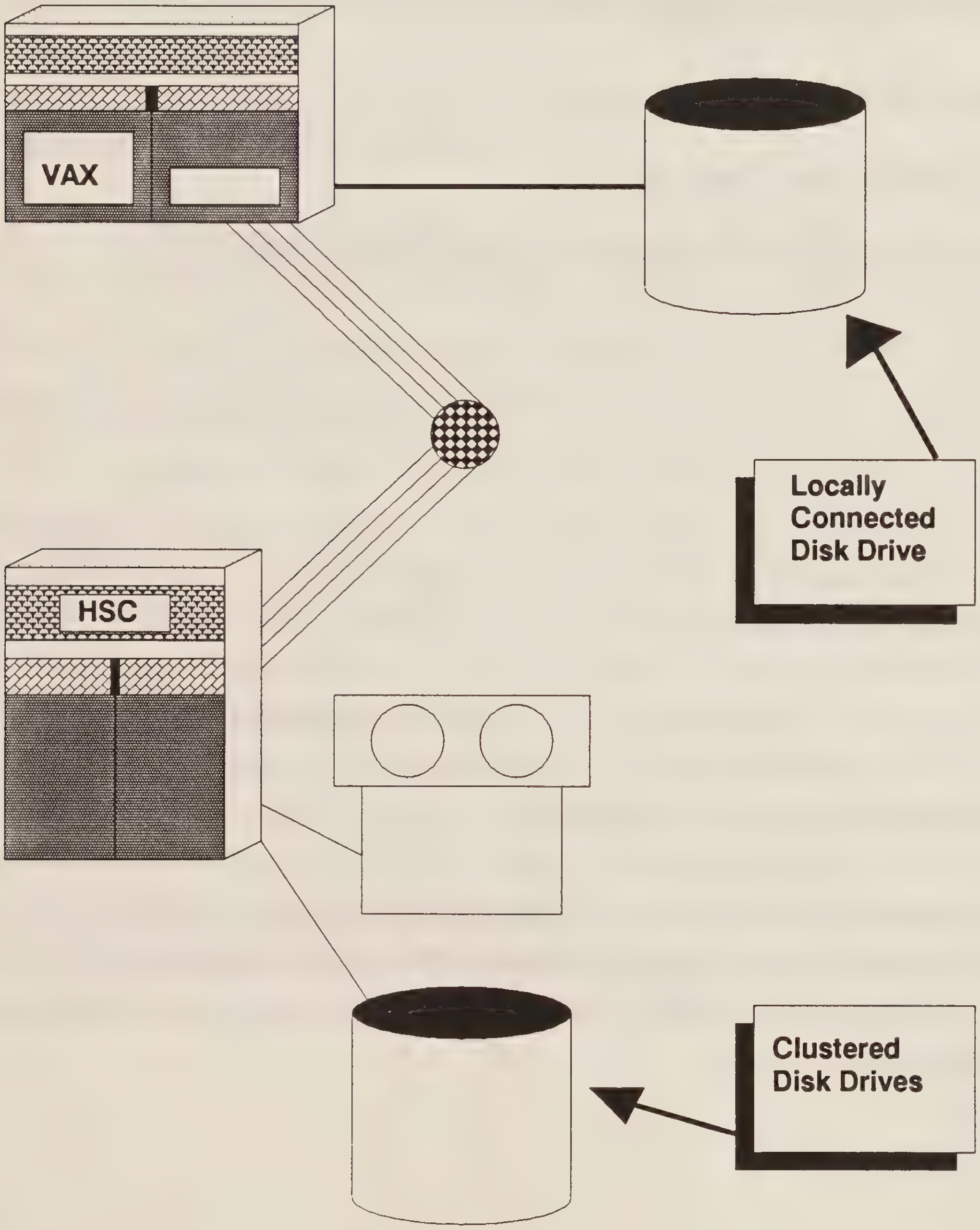
    > HSC50 has a queue for over 1000 host I/O requests. Can support twenty-four disk drives or DSA tape drives. 128 KBytes buffer space.

    > HSC40 replaces the HSC50. Can process up to 1,150 I/O requests/s. Upgradeable to a HSC70.

    > HSC70 has queue for over 2000 host I/O requests. Can support thirty-two disk and tape drives. Up to 512 KBytes buffer space.

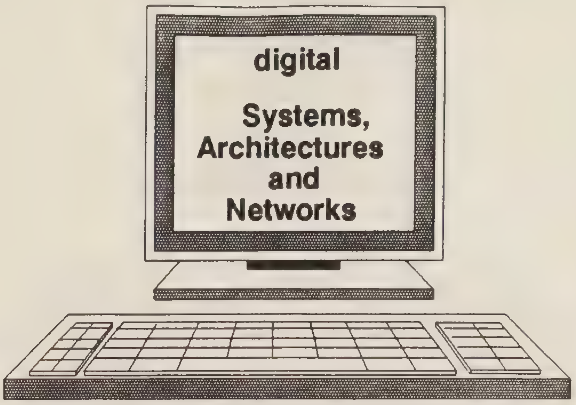
- Each HSC can support all the hosts on the cluster. Individual disks can be dual ported to multiple HSCs.

HSC Connected Storage Devices



Board Level DSA Controllers

- Each type of bus has its own controller. All three types offer:
  - > Up to 20 host I/O requests.
  - > Up to 4 SDI devices.
  - > Data buffering (disk cache).
  - > Direct controller-host memory transfers (DMA).
- The UDA50 is used for Unibus configurations. Will use two Unibus slots. A limit of two UDA50 controllers per Unibus. Sustained throughput of 750 KBytes/s.
- The KDA50 is the equivalent device for Q-bus systems. Consumes two slots on the Q-bus. Has a limit of two controllers per Q-bus. Sustained throughput of 880 KBytes/s.
- KDB50 is used for VAXBI bus systems. Consumes two slots on the VAXBI bus. Four KDB50s can be attached to a single VAXBI bus. Sustained throughput of 1 MByte/s.
- Clearpoint makes a DSB disk-controller sub-system that replaces the KDB50. The sub-system attaches directly to the VAXBI bus and supports 7 devices. Clearpoint claims performance is three and half faster and the price is 25% to 50% less.



DSA Compatible Disk Drives

- The RA90 is a 1.2 GBytes fixed drive. Peak transfer rate of 2.8 MBytes/s.

- The RA82 is a 622 MBytes fixed disk system. Peak transfer rate of 2.4 MBytes/s, average access time of 32.3 ms.

- The RF71 is a 400MByte disk drive. Attaches to the DSSI bus. Uses the KFQSA Q-bus adaptor to attach RF series drives to MicroVAX II or 3500/3600.

- The RA70 is a 280 MBytes disk drive, initially packaged only with the MicroVAX 3000 systems. Peak transfer rate of 1.4 MBytes/s, average access time of 27 ms.

- The RA60 is a 205 MBytes removable media disk. Peak transfer rate of 2 MBytes/s, average access time of 50 ms. Can be dual ported to two different VAXes or HSC controllers.

- The RF30 is a DSA, 150 MBytes disk drive. Average access of 34.5 ms. Can be dual ported using the DSSI bus, to multiple MicroVAX 3300/3400 systems. With a Local Area VAXcluster, this permits the drive to remain accessible in the case of a system failure.

ESE20 Solid State Disk

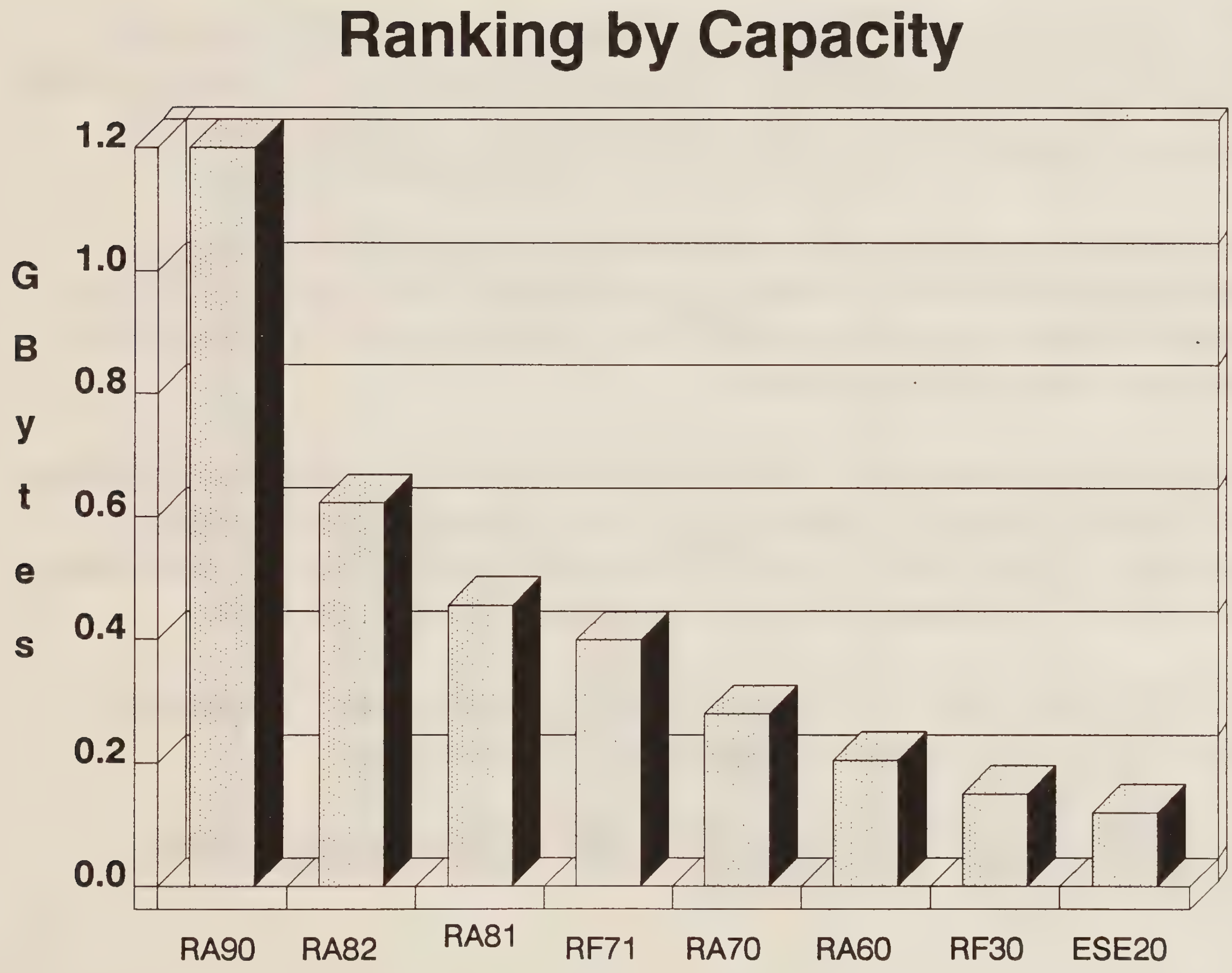
- The ESE20 is a 120 MByte solid-state storage device. Fully DSA-compatible, the ESE20 can be integrated into an existing VAX environment without application software modification.

- The best use of the device is for I/O intensive applications. The performance of the ESE20 is about 10 times faster than the fastest magnetic disk. You can expect a performance boost of 10 to 50 percent.

- The ESE20 is a full member of the DSA family. They support volume shadowing. Also multiple ESE20s can be linked by VMS as bound volumes for larger storage requirements.

- The U.S. list price for the ESE20 is $110,000. Expect the price to decrease and the storage capacity to increase over the next year or so.

DSA Comparison Chart



[DSADRIVE]

Disk Clusters (Storage Arrays)

- Many vendors, including DEC, are prepackaging several drives and a controller into small floor-space packages.

- DEC's SA482 puts four RA82 drives into a 5.5 square foot rack and delivers 2.5 GBytes of storage. The array is intended to be used on one system. High throughput is achieved by four independent parallel spindles, allowing multi-path, multi-spindle throughput.

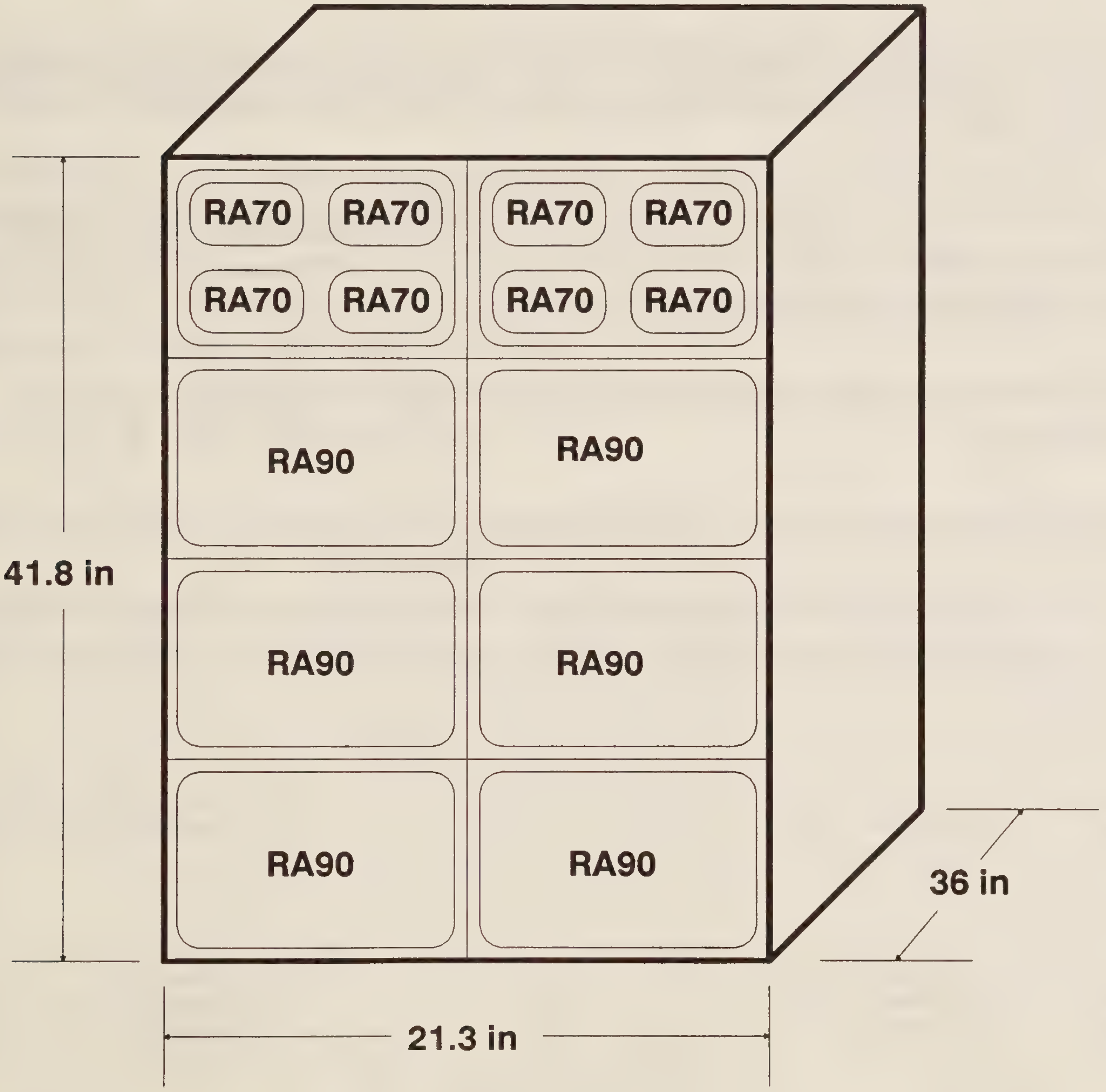
- Average access time is 32.3 ms/spindle. This system was designed specifically for HSC50/70 systems, especially where they are used to support VMS volume shadowing. The system could be used on any of the board level DSA controllers.

- The SA600 Storage Array contains eight RA90 drives. This arrangement provides 9.6 GBytes of storage. Will use 8 channels on the HSC. A maximum of four SA600 arrays can be attached to a HSC70, providing 38.8 GBytes of storage. Requires an update of HSC software.

- The SA650 has eight RA70 drives and six RA90 drives. Frequently accessed files are stored on the faster RA70 drives.

- The SA550 has eight RA70 and three RA81 drives in one cabinet. Maximum capacity of 4.1 GBytes.

SA650 Storage Array

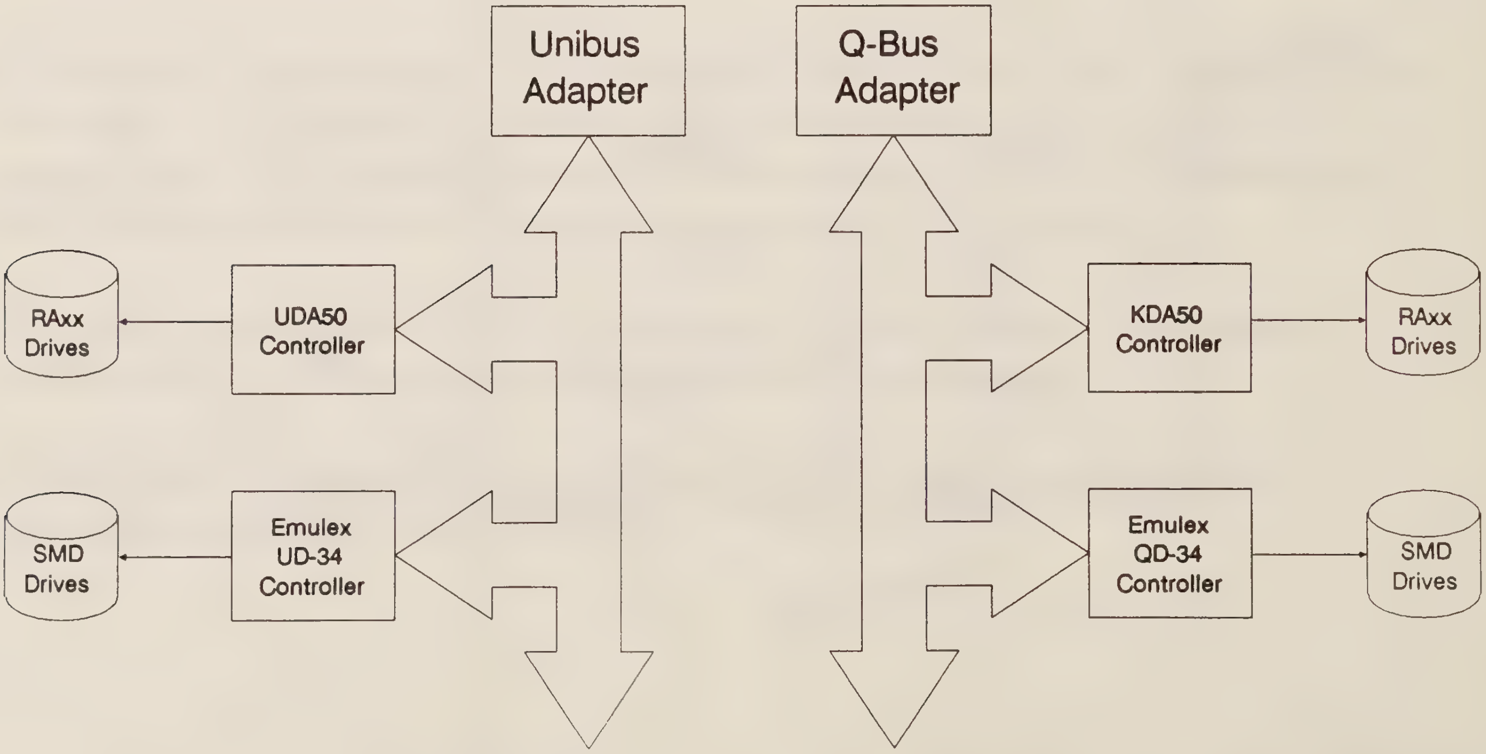


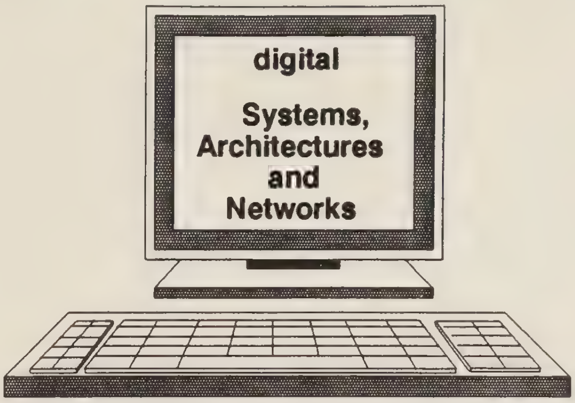
Storage Module Device Interface Disk Drives

- **CDC created the Storage Module Device interface several years ago. Many non-DEC drive manufacturers use this, including CDC, Hitachi, NEC and Fujitsu.**

- **Emulex makes a UD-34 controller which attaches SMD drives to VAX Unibus systems with maximum throughput of 3 MBytes/s. The QD-34 is the Q-Bus model controller.**

- **The Extended SMD interface will support high throughput up to 3.5 MBytes/s.**





Lower Capacity Winchester Drives

- A variety of options are available for 200 MBytes or less Winchester drives. DEC markets the RQDX3 controller for Q-bus systems.
- The RD52 is a 31 MBytes fixed disk winchester drive. 5.25 inch sealed media. Transfer rate of 625 KBytes/s.
- The RD53 is a 71 MBytes fixed disk Winchester. Transfer rate of 625 KBytes/s, average seek time of 30 ms.
- The RD54 is a 159 MBytes drive.
- Note that these drives do not use the DSA controllers mentioned earlier.
- An alternative for low capacity drives is the Small Computer Standard Interface (SCSI). Transfer rates of up to 1.5 MBytes/s are supported.

Tape Drives

- The TA79 connects to HSC systems. Each HSC5-CA (Slot on an HSC50 or HSC70) supports four TA79 drives.
- Consists of a TA79-BF/BJ master tape subsystem and up to three TU79-AF/AJ add-on systems.
- Read-write speed of 125 in/s. Supports 1600 and 6250 bpi.
- The TA81 is a low-end HSC device - read speed of 75 in/s and write speed of 25 in/s.
- The TU81-Plus works on VAXBI, Q- or Unibus systems. 256 KBytes cache; read/write speeds of 75 and 25 in/s.
- Storage Technology and Control Data Corporation are two other large suppliers of tape drives for DEC equipment.

Tape Cartridges

- Cartridge tapes are rapidly replacing traditional 9 track magnetic tape drives.
- The TK50 is a cartridge tape system for MicroVAXes. The TK50 uses a 1/2-inch tape and holds 95 MBytes (as compared to roughly 200 MBytes for a tape reel).
- The recently announced TK70 holds 296 MBytes and is upwardly compatible with TK50 cartridges. The TK70 is designed to hold the entire contents of an RA70 disk drive.
- Emulex has a 1/2-inch MT750 cartridge which holds 620 MBytes.
- These cartridges are not compatible with the IBM 3480 systems.
- DEC and IBM have signed an agreement where DEC will OEM IBM's 3480 tape drives. This 1/2-inch drive has a maximum of 220 MBytes of storage. Big advantages in interchangeability between DEC and IBM, and the 3 MBytes/s transfer rate of the 3480.

RRD40 CD-ROM

- The RRD40 is DEC's CD Reader with Read Only Memory. Each disc holds 600 MBytes of formatted data. Works on the Q-bus and SCSI. Average transfer rate of 150 KBytes/s, average access time of 500 ms. Uses the Phillips/Sony standard for compact disks.

- Designed to be used with DECwindows. The entire 20 feet of VMS documentation can be replaced with one disc. Using the book reader feature in DECwindows, the documentation can be searched in seconds versus hours. Can also house the operating system for VAXstation 3100, allowing non-computer folks to perform some system management functions.

- Several third party vendors have products available. Eastman Kodak and EMC are two players in this market. Vendors are providing optical disc jukeboxes with storage capacities of 1 TByte of data. These jukeboxes emulate traditional VAX tape drives, allowing the optical disc to be installed without modifying device drivers on the VAX.

- The RV64 is DEC's optical jukebox. The WORM 12-inch disks can hold 2 GBytes of data each. The jukebox can hold 64 platters for a total capacity of 128 GBytes of on-line storage. Access time of 212ms.

Other Peripheral I/O Devices

- **Asynchronous Communications Controllers**
- **Synchronous Communications Controllers**
- **Printers**
  - > Postscript Printers
  - > Non-Postscript Printers
- **Terminals**
  - > VT-Compatible Terminals
  - > PCs
  - > DECtalk
  - > EL Flat Panel Displays

Asynchronous Communications Controllers

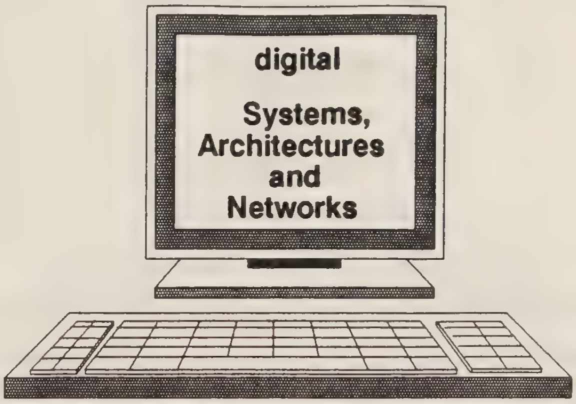
- Used to attach terminals, printers, modems and other communication devices to the system.

- Many of these devices are being replaced by network-based solutions such as terminal servers or print servers.

- DMA (Direct Memory Access) allows groups of characters to be deposited directly in main memory, thereby alleviating the need for a CPU interrupt for every character received.

- The DMB32 and DMF32 also have a single line synchronous interface and a general purpose parallel port. Typically, the synchronous line is 19.2 Kbps and is used for a DDCMP connection to another VAX. The parallel port is typically used for a line printer.

Controller	Bus	Lines	DMA	Speed
DZQ11	Q	4	No	9.6 Kbps
DHQ11	Q	8	Yes	38.4 Kbps
DMZ32	Unibus	24	Yes	19.2 Kbps
DMF32	Unibus	8	Yes	19.2 Kbps
DMB32	BI	8	Yes	38.4 Kbps
DHB32	BI	16	Yes	38.4 Kbps



VT Series Terminals

- The current DEC terminals are the VT300 series. The VT330 is a monochrome graphics terminal and the VT 340 has color support. The VT320 terminal has replaced the VT220.

- The VT320 terminal offers much of the functionally of its third party competitors. AT $545.00 each, the VT320 is very good buy. Standard features include one page of memory, two I/O ports and a 25x132 display. Most terminal vendors compete by offering enhanced capabilities. For example, more memory, higher resolution and more ergonomic features.

- Some factors to consider:

    > Compatibility: Ensure the terminal is VT220/320 compatible.

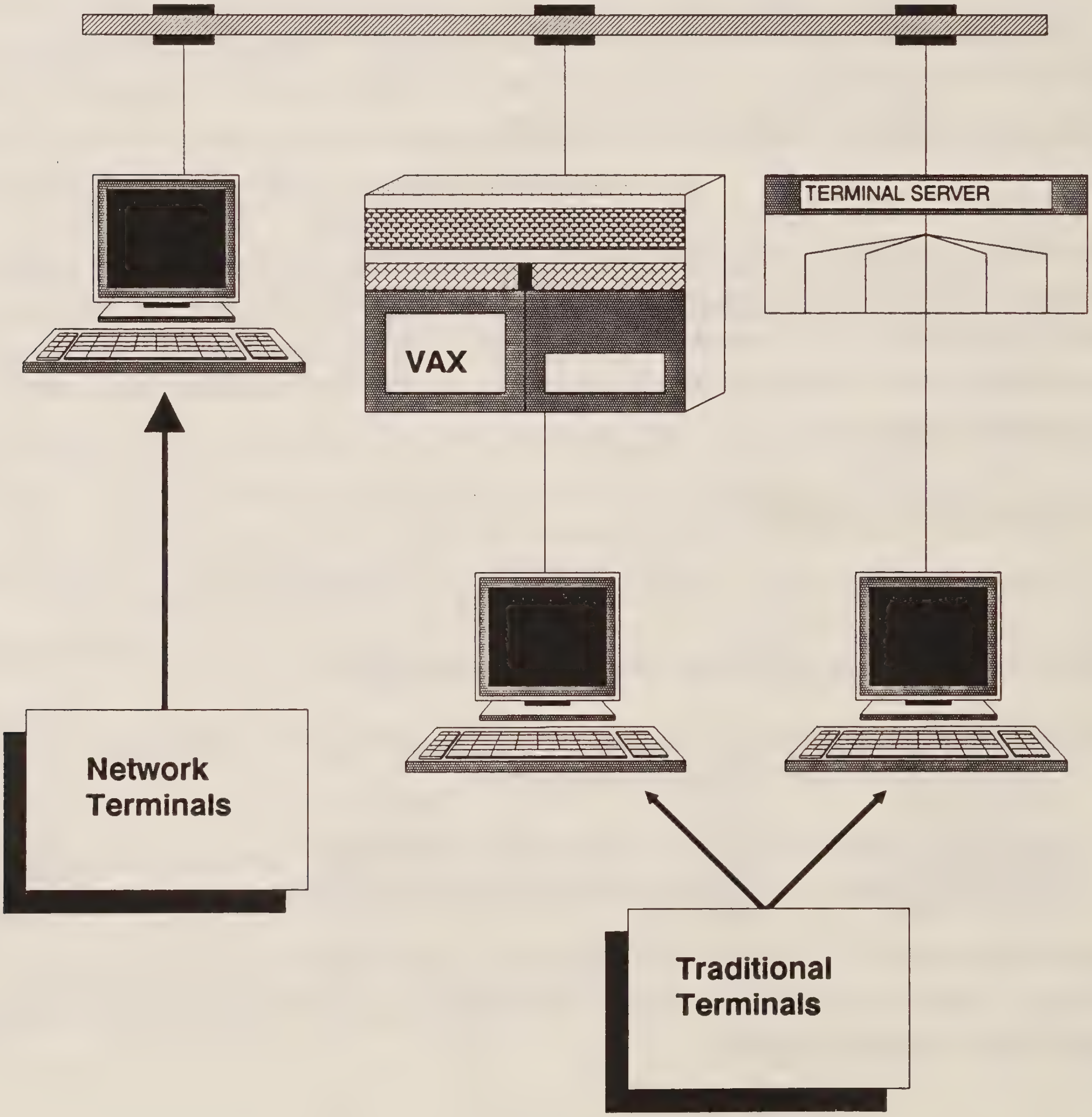
    > Price: Ranges from low $400s to over $2,900.

    > Features: You can get 2, 3, 4 or 5 I/O ports, up to 32 pages of memory and windowing capabilities.

    > Display: A 24 line by 132 column is standard. You can get up to a 50x132 display. 14 inch is standard display size.

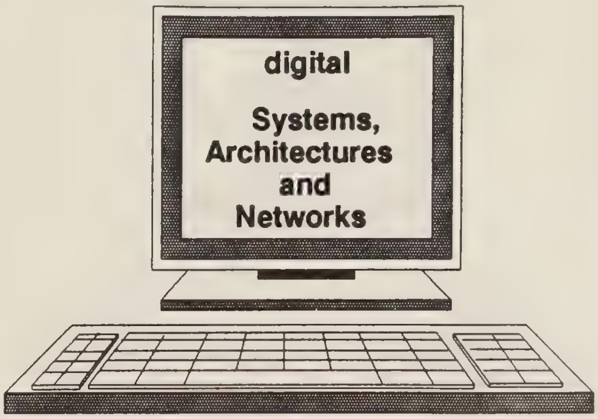
- Network terminal running X-Windows are available from third party sources. Costs are between $995 - $2,500. Expect DEC to announce a similar type terminal soon.

Ways to Connect Terminals



Network Terminals

Traditional Terminals



DECtalk and Flat Panel Displays

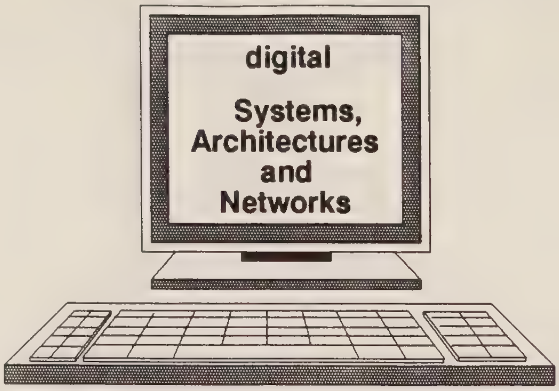
- DECtalk. Can "speak" a file using ten different voices and includes a user-defined dictionary of pronunciation. Integration into a telephone system makes this a front end for customer service systems and can allow remote access to Email files. Has been used to allow access to computers by the blind.

- DECtalk comes in single line, dual line or eight line models.

- User defined dictionary allows you a customized vocabulary.

- DEC has plans to market a 19-inch electroluminescent (EL) flat panel monitor. The EL flat panel displays would be used on workstations where space is at a premium.

- The EL panels will offer enhanced optical performance, reliability and lower power consumption. The panels will be available for both VAXstations and RISC workstations.



Printers

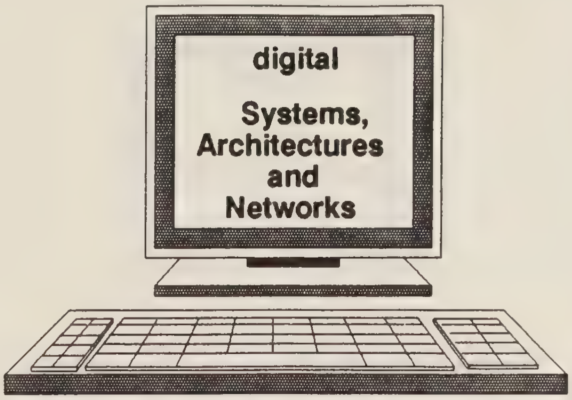
- The LA series are draft quality dot matrix printers. The LA75 and LA210 are small personal printers, PC-compatible, and very similar to the Epson or Panasonic models.

- The LA100 is a desktop keyboard send/receive (KSR) terminal. Can be used as a console terminal device. The LA120 DECwriter III is a pedestal mounted KSR terminal also used as a console device.

- The LJ250 and LCG01 are color desktop printers. Both have serial and Centronic interfaces available. Used to print high-quality graphics and text documents. The LCG01 contains a CPU that can offload the graphics processing from the host system.

- LNO3 Plus is a 8 ppm, 300 dpi laser printer with 1 MByte of RAM. Uses font cartridges to supplement the basic 16 resident fonts. Non Postscript printer. The LNO3 can be upgraded to support Postscript (then called a LN03R Scriptprinter).

- DEC's Postscript printer is the LPS40 Printserver which operates at 40 ppm and works on an Ethernet system. Must be down-line loaded from a host. Using systems must have Client software to use the Printer. Duty cycle of 50,000 pages/month.



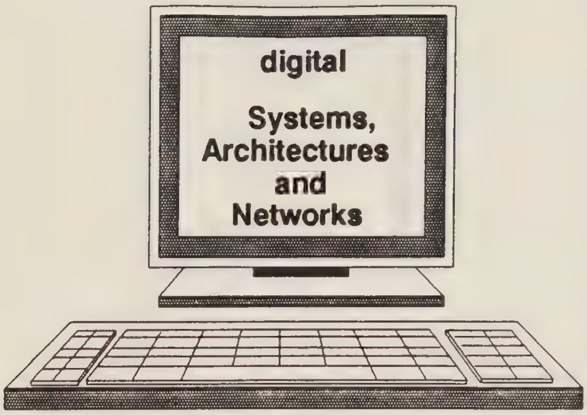
More Printers

- LPXX series are DEC lineprinters. The LP29 operates at 2,000 lpm. Duty cycle of 300,000 pages/month. The LP25 operates at 1,200 lpm, depending on the size of the character set.

- The LGO2 is also a line printer, capable of 480 lpm with upper/lower case. In addition, it can produce barcodes, subscripts, superscripts, bolding and text rotation. The LG02 is LNO3 compatible.

Future Directions

- **Changing Architectures**
- **Parallel Processing**
- **RISC Computers**
- **Bus Speeds**



Changing Network and Computer Architectures

	Category	1984	1987	Now Available
Processors	Example	VAX 11/780	VAX 8800	Elxsi 6460
	MIPS	1VUP	10 VUPs	240 VUPs
	Main Memory	8MBytes	128 MBytes	2 GByte
	Storage	500 MBytes	3 GBytes	1 TByte
	Communication	9.6-56 Kbps	10 Mbps	80 Mbps
Workstations	Example	PC/XT	MicroVAX II	DECstation 5800
	MIPS		.85 VUP	18 VUPs
	Main Memory	640 K	8 MBytes	64 MBytes
	Storage	10 MBytes	72 MBytes	560 MBytes
	Communication	1.2 Kbps	10 Mbps	10 Mbps

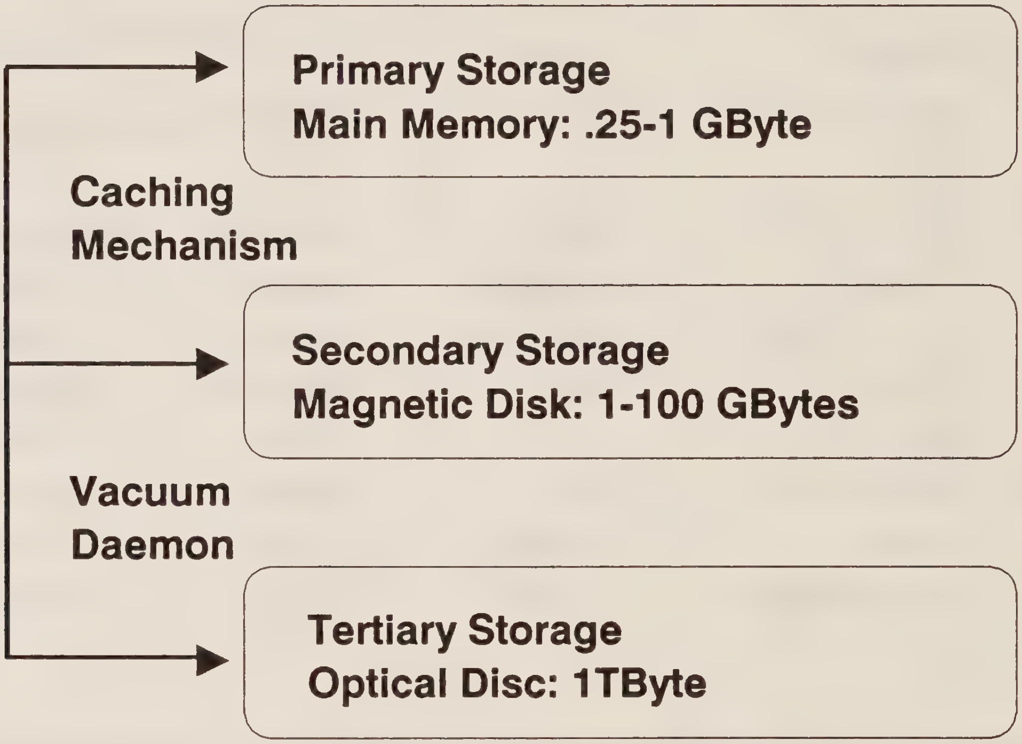
[CHANARCH]

- In developing a long-term information architecture, it is important to consider several changes in the underlying machine and communication platforms that software systems will run on.

- Note that VUP (MIP) ratings are just one factor in evaluating the throughput of a particular machine. Other factors are memory, bus speeds, disk speeds, and all the other balanced components of a system.

- It is dangerous to compare MIP ratings across machine architectures. The VAX, with a comparatively large instruction set, does more in one instruction than a Reduced Instruction Set Computer (RISC) might do.

Mass Storage



Primary Storage
Main Memory: .25-1 GByte

Caching
Mechanism

Secondary Storage
Magnetic Disk: 1-100 GBytes

Vacuum
Daemon

Tertiary Storage
Optical Disc: 1TByte

- Massive Main Memory. Companies such as Gould have already announced systems with minimum main memories of 256 MBytes. 8800 series is up to 512 MBytes.

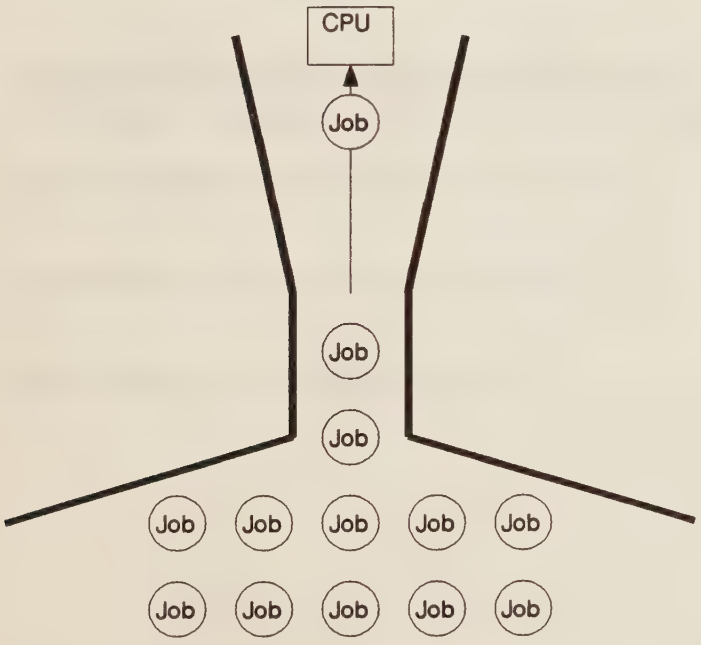
- Massive Tertiary Storage. TBytes of optical disc storage using jukeboxes are already available for VAX computers.

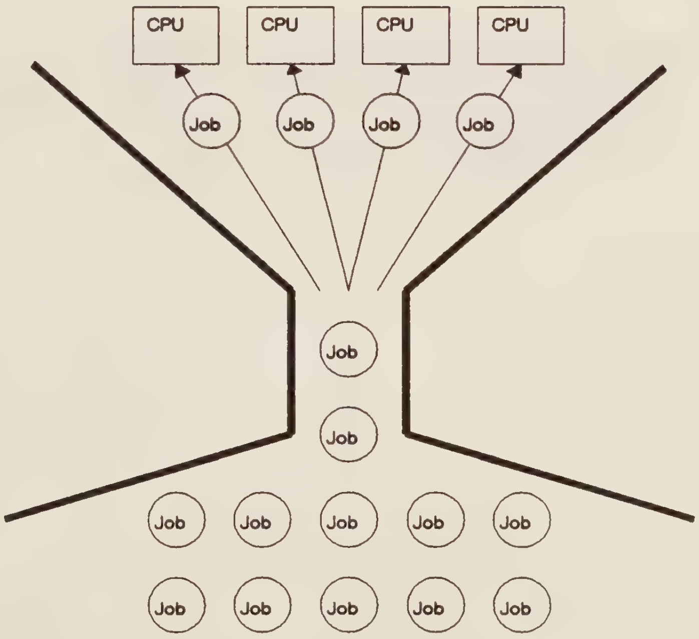
- DBMS developers are using these changing platforms as assumptions for the next generation of DBMS systems. Users need to also plan for this next generation of hardware, software and networks.

Vector and Parallel Processing

- Parallel processing is a definite direction for DEC products. The VAX 6000, 8800, and VAXstation 3520/40 use the parallel technology now. You can expect DEC and other vendors to continue to use multiple CPUs as the primary method of achieving higher performance.

- A parallel processor works at the individual process level. A vector processor takes multiple instances on a single arithmetic operation and does all the operations simultaneously. A vector processor is much more granular than a parallel processor.





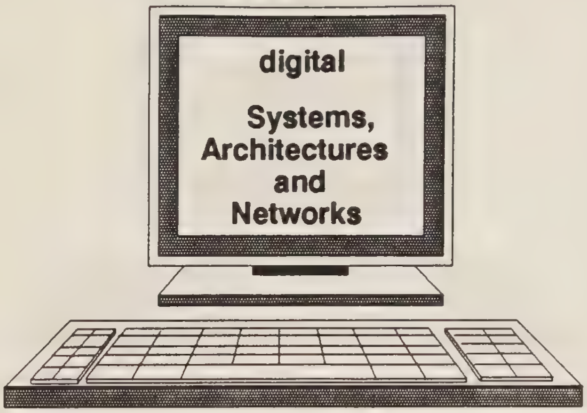
RISC Technology and Bus Speeds

- As the number of CPUs per bus increase, the limitations of the memory bus and I/O bus will become more apparent.

- DEC has not announced plans for the VAXBI bus. However, DEC's new VAX 9000 series computers are expected to use the XMI (100 MBytes) as the I/O bus. The memory bus is expected to be close to 1 GByte/s.

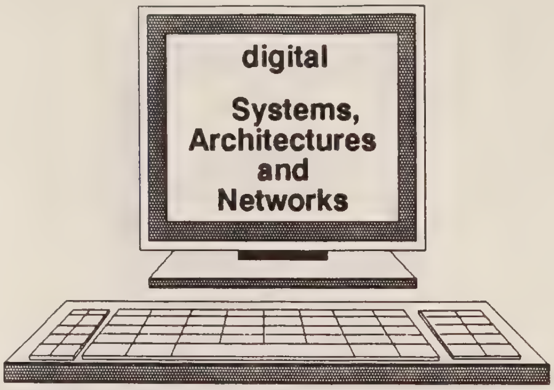
- RISC (Reduced Instruction Set Computer) technology has been used by several DEC competitors. The current wisdom among industry analysts is that the VMS instruction set is too large to accommodate a RISC-based processor.

- DEC has developed a RISC-based processor, the Titan and Multi-Titan projects. They ran Unix (but not VMS), and never came to market. DEC now OEMs a RISC processor.



System Configuration Considerations

- Numbers of concurrent users?
- Working set requirements?
- Static memory requirements?
- Immediate on-line storage requirements?
- Expansion of storage? Memory? Users?
- High availability requirements?
- Environmental requirements?
- CPU intensity? I/O intensity?
- Multi-vendor connectivity?
- COST OF OWNERSHIP?



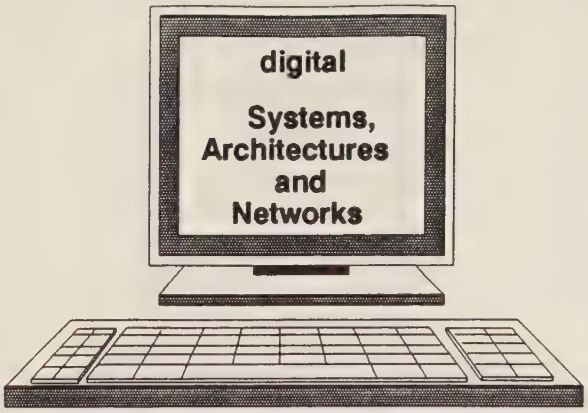
DIGITAL HARDWARE PRODUCTS

Key Concepts in This Section

- Balanced Systems. A powerful CPU must be balanced with the proper amount of main memory, I/O channels, disk drives and other peripherals.

- Evolution of VAX Systems. VAXes are moving toward parallel processing with high-speed buses. Another trend towards distributed processing dedicates more and more tasks to specially designed systems. Examples are the HSC storage controllers.

- Storage Architectures. Both SMD and DSA provide an architecture that allows disk controllers and disk drives to properly interface. This provides portability across different machines that support the same architectures.



Exercise: Configuring a VAX System

- You've been asked to provide a preliminary configuration for a system to replace the computer used by the corporate administrative support staff.

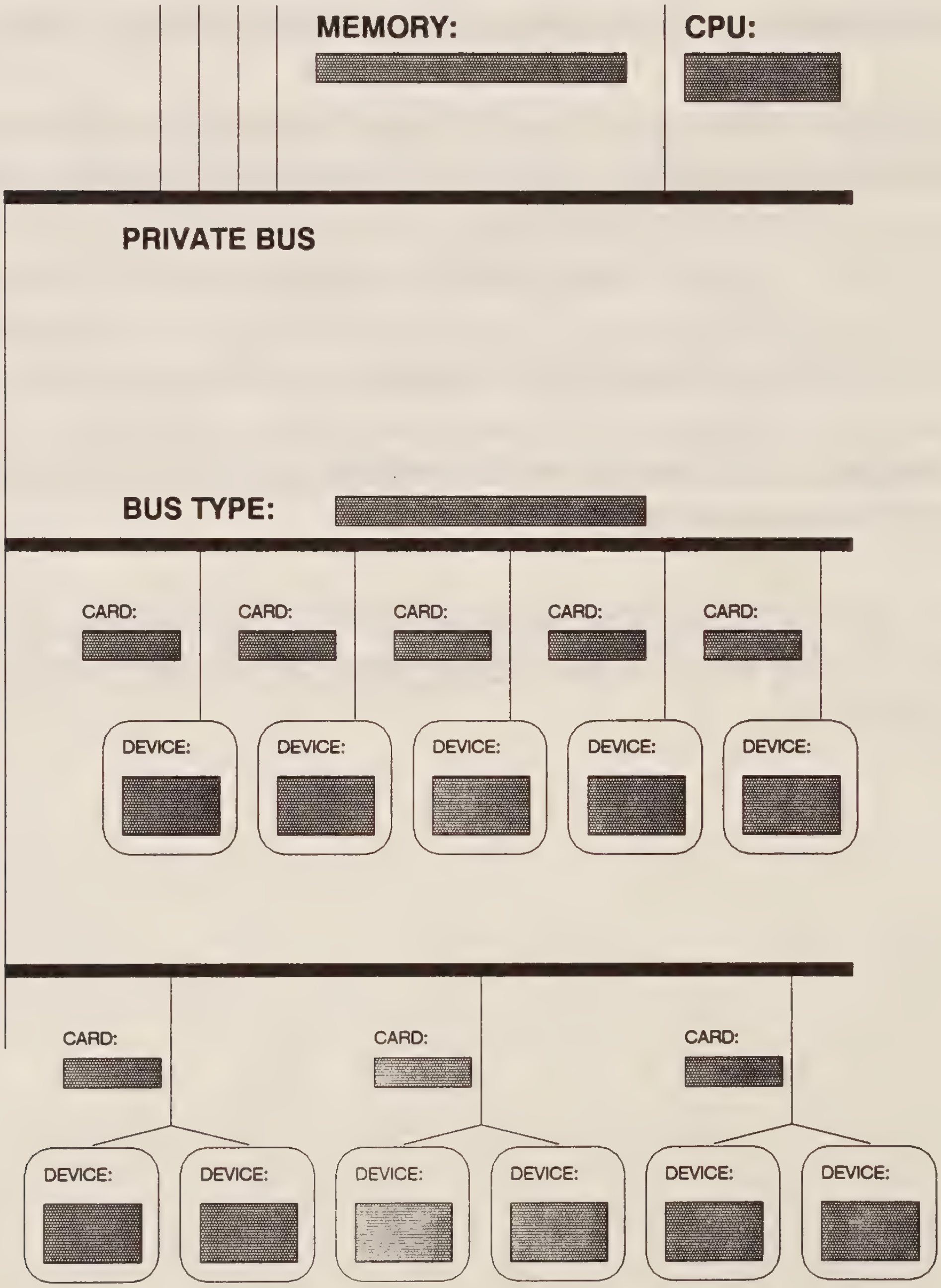
- The system will have to support a word processing pool, personnel and building maintenance. You're not quite sure of all the user requirements.

- To the best of your knowledge, you'll have to support 48 users with roughly 1 GByte of disk space. The system will have database, spreadsheet, word processing and electronic mail.

- Fill in the attached CPU configuration sheet as a first cut on the hardware you'll recommend.

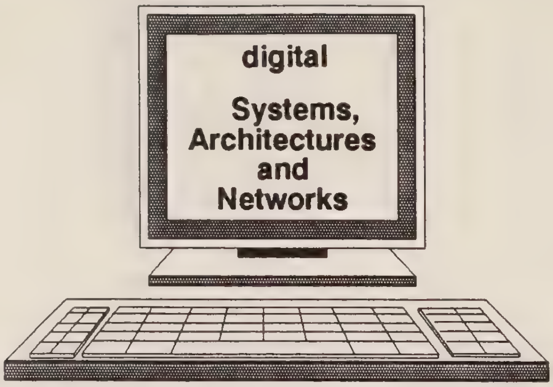
- If you had the option of buying multiple CPUs, how would you distribute the load? Don't worry about connecting the CPUs; we'll do that in the networking sections.

Configuration Problem

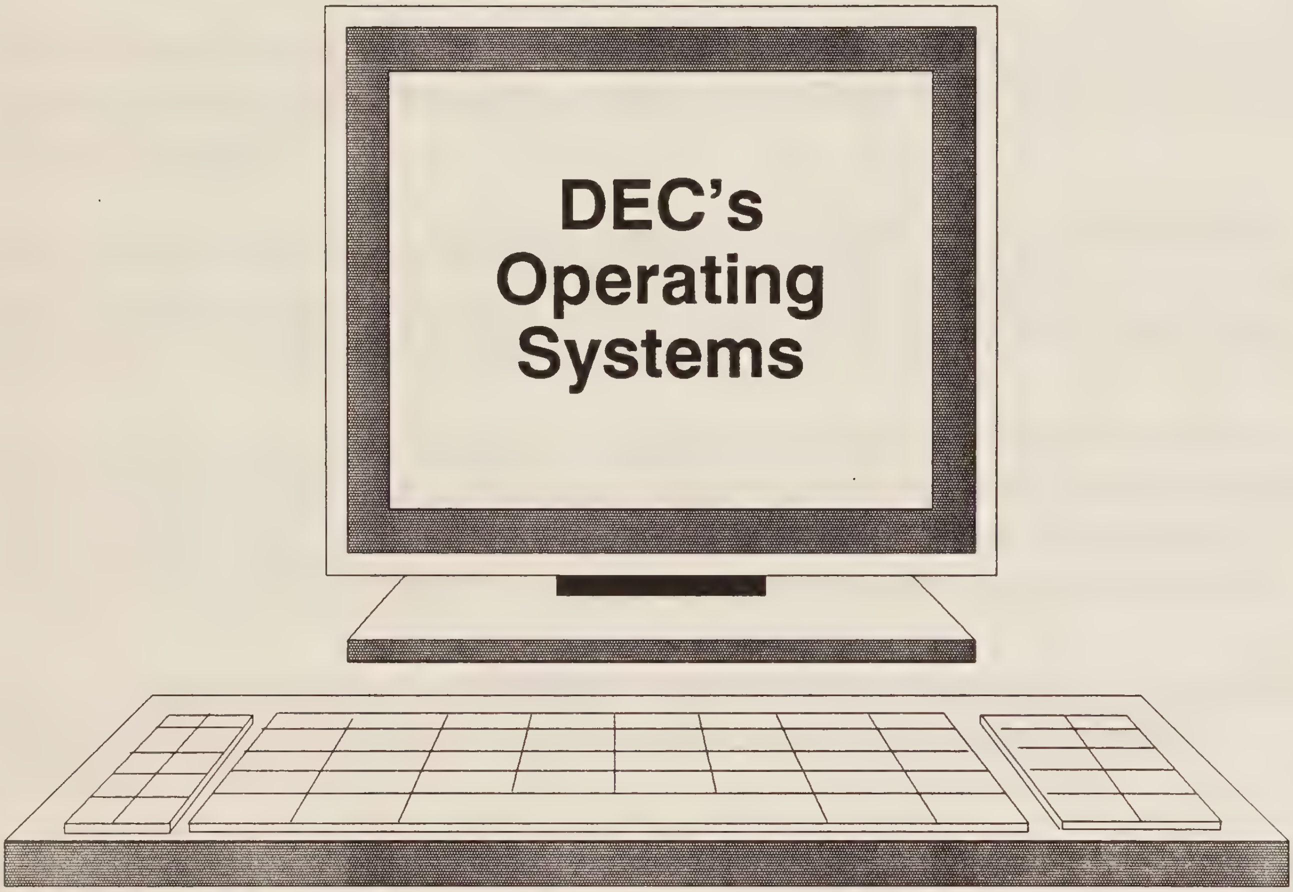


"Thinking is the hardest work there is, which is probably the reason so few engage in it."

Henry Ford

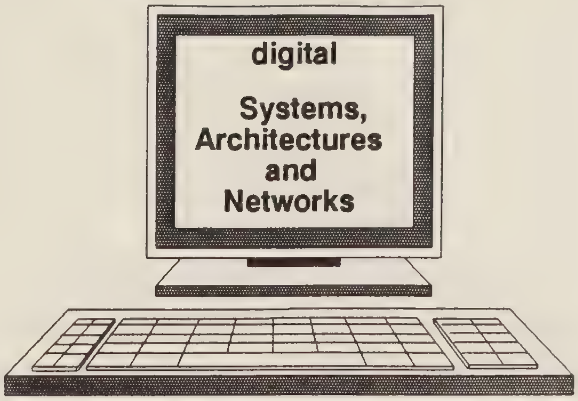


DIGITAL HARDWARE PRODUCTS



DEC's Operating Systems

OPERATING SYSTEMS



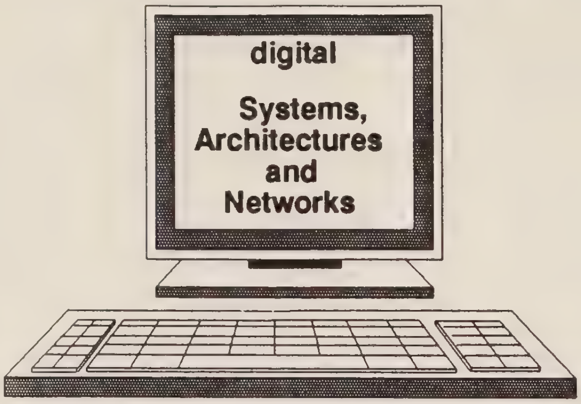
Overview

- Virtual Memory System is the most fully supported of the three operating systems sold by DEC. The other two are VAXeln (Real time) and Ultrix (a Unix derivative).

- DEC software development and network support focus on VMS and Ultrix. Using heterogeneous network architectures, you can integrate DECnet (VMS) with heterogeneous systems (Unix, TCP/IP, SNA, etc.).

- ULtrix is the system of choice for software development. It is written in the C programming language, providing easy interchange between the operating systems and software developed in C. Ultrix has a large variety of tools (over 200) designed to help the program developer.

- Ultrix is DEC's version of 4.3BSD. Ultrix has DECnet support and lets you put an Ultrix machine on a network as a non-routing end node.



VAXeln

- VAXeln stands for VAX Executive for Local area Network. It is an operating system kernel that supports realtime applications.

- The applications themselves are written in standard high-level languages such as C, Ada, FORTRAN or Pascal. The applications are written and compiled on a host VAX running VMS. When the application is complete, the target computer, running VAXeln, is downline loaded or rebooted with the application. VAXeln then runs the application.

- Most VAXeln applications are 100% memory resident (non-paged). Thus, disk and tape drives are not required. The host computer provides storage and print server functions to the VAXeln computer. The host also runs the VAXeln system management tools.

    > ELN Command Language

    > ELN Resource Monitor

    > ELN Performance Analyzer

    > ELN error-log facility

- Typical realtime applications include flight simulators, nuclear power plant control monitoring, environmental controls and manufacturing floor control.

Unix Background

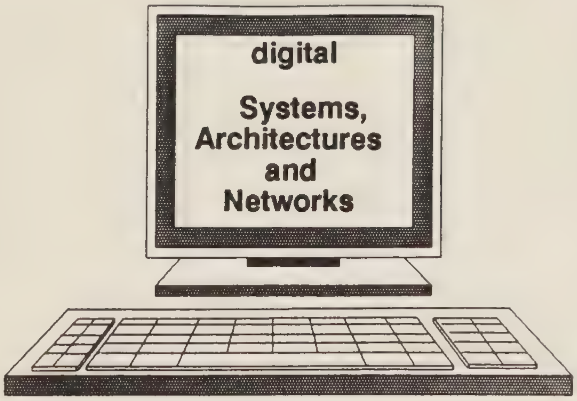
- Unix was developed by AT&T. AT&T has continued to enhance Unix and now markets Unix System V.3. The Defense Advanced Research Projects Agency (DARPA) sponsored major enhancements to Unix at the University of California at Berkeley, resulting in another derivative called Unix 4.2 Berkeley Standard Distribution (4.2BSD). Sun Microsystems enhanced the System V Unix and developed their own Sun OS.

- Then, Sun Microsystems and AT&T have signed an agreement to converge their two versions of the operating systems. This caused concern on the part of other Unix vendors. Prime argument was that Sun would have a six month lead in marketing the standard Unix. Thus, the Open Software Foundation (OSF) was formed by DEC, IBM, Apollo, HP and others to create a true non-proprietary, "open" Unix.

- Today, we have three major Unix "standards". The Berkeley 4.3 version, the AT&T/Sun System V version and the IBM AIX version. OSF is supporting the IBM AIX version.

Ultrix-32

- Ultrix-32 version 3.0 is IEEE P1003.1 (POSIX) compliant. It is also compliant with:
    - > X/Open Portability Guide 2 (European standard)
    - > OSF Level 0 Application Environment Specifications
    - > Issue 2 of AT&T's System V Interface Definition (SVID)
- Ultrix 3.0 includes Sun's Network File System (NFS), supports distributed record locking and provides support for the new CPUs. It also supports the CI bus and HSCs. You should now be able to have Ultrix based VAXclusters.
- With the VMS/Ultrix Connection, you can have Ultrix clients on a VMS server. Ultrix workstations can now use your Ethernet network without affecting the management of the disk farm.



POSIX

- In 1985, AT&T developed the System V Interface Definition (SVID) to help solve some of the Unix incompatibilities. SVID is the external interface specifications and does not define the operating system.

- A non-profit organization, /usr/group, was also working on the Unix standardization. This group developed a specification for a portable operating system. The idea was to have a common OS base on which to build Unix applications.

- The IEEE P1003 Standards Committee formed in January 1985 used the /usr/group document as a starting point. The IEEE committee is working toward an ANSI standard for the Unix OS. In April 1986, the IEEE P1003.1 Trial-Use Standard for the Portable Operating System Interface (POSIX) was released. The P1003.1 specification was approved in August 1988.

- POSIX is the de facto standard for an operating system interface. All major organizations involved in open systems have adopted POSIX. The federal government now requires all new operating systems to be POSIX compatible.

Ultrix Concepts

- Pipes and Redirection (Modular Construction)
- The Shells (Alternative User Interfaces)
- Editors (Metacharacters)
- AWK, YACC, LEX (Programmer Utilities)
- UUCP, USENET (Communications Support)

Redirection and Pipes

- Ultrix is an extremely modular system. Pipes and redirection are the way to put the tools together to solve problems.

- Redirection allows the input, output and error message of any program to come from the terminal or from some other program. Typically programs are designed to read from standard input (the terminal) and write to standard output (the terminal). If you want to, you redirect these streams.

- Pipes allow you to make the standard output from one program become the standard input to the next one.

```
unix% who | wc-l
```

The Shells

- The SHELL plays the same function of command interpreter that the DCL language does in VMS. This is the user interface to the Kernel. Both the C-Shell (4.2BSD) and the Bourne Shell (System V) are typically available in both environments.

- The C-Shell is very similar to the C programming language but with the addition of higher level constructs for interactive and systems type scripts.

- The Bourne Shell is the traditional System V shell.

- Shell scripts can be installed as commands. This allows you to build an interface on top of the generic facilities.

```
date
echo  "Working Directory:’
pwd
echo  ’***FILES***’
ls
```

Editors

- Several different editors have evolved over the years. ED, the original editor, defined many of the pattern search strings that are available in Unix. Example: Enclose all lines beginning with PROC and ending with DEF in curly braces.

```
s/PROC.*DEF/(&)/p
```

{ }

- SED is an non-interactive stream editor. It allows you to apply changes to lines without going into an interactive session, as opposed to an editor like ED which expects to "see" a user. Another advantage of SED is that it only holds one line at a time in memory, thus allowing much larger files to be edited.

- VI is a 4.2 enhancement written by Bill Joy. Along with EMACS, it is a standard feature on most versions of UNIX. Although it's cryptic, VI is very powerful.

Pattern Searches

- Several tools allow you to search files for complicated patterns, then take actions based on the results. GREP writes any occurrences of specific strings to standard output . For example, if you want to get an alphabetical list of all the subroutine names in a text file, you would do the following:

```
unix%grep '*subroutine*' file1 | sort output.file
```

- AWK is a general purpose pattern scanner that allows you to take complex actions based on the type of input. To take the first word of every line in the current directory:

```
awk'[ print $1 ]'* log.file
```

- AWK is ideal for reformatting data from foreign sources.

- A wide variety of other tools, such as the YACC/LEX parser generation utilities, exists in the Unix environment.

- Other tools available include a make utility (the equivalent of VMS MMS) and the sccs utility (the equivalent of VMS CMS). These tools are available under VMS with the DECshell package.

UUCP and Usenet

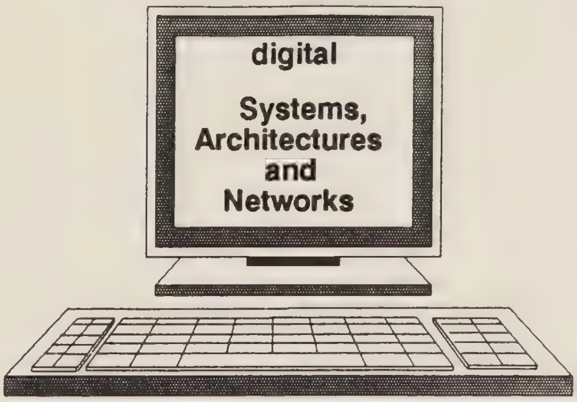
- UUCP (Unix to Unix Copy Program) is a very low cost scheme for allowing Unix systems to exchange files over dial-up lines.

- Each system has a uucp daemon. The daemon wakes up at specified times and looks for files queued for transfer to another system. It then dials the other system and transfers the files.

- UUCP is used frequently for mail systems and for the transfer of a loosely-coupled bulletin board system called Usenet. With Usenet, information is posted on the net. Systems pass the information along to the next node, which passes it on to the next node... This means that you're never quite sure when your message will arrive at all other nodes.

- Usenet has over 500,000 participants and is considered one of the oldest networking schemes. It relies on autonomously administered nodes cooperating with each other. Each node agrees to pass information along to another system if they request it. Many universities agree to act as gateways and transfer information along to several nodes.

UUCP



Virtual Memory System (VMS)

- The Digital Command Language (DCL) is a command interpreter. VMS has facilities for other command interpreters, but DCL is the primary one. DCL is akin to the Unix concept of a shell. The command interpreter is what users see as their interface to the operating system.

- DCL capabilities include:

  > I/O Operations

  > Execute Other Images (Run Programs)

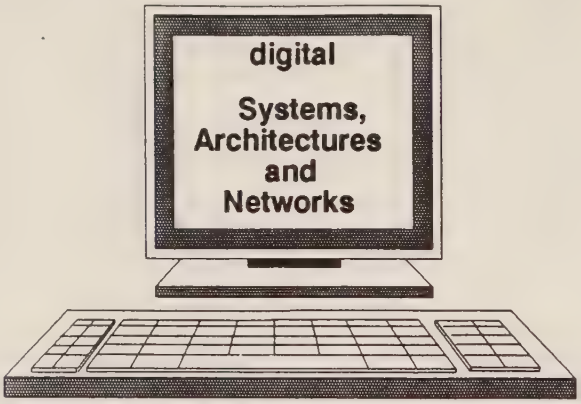
  > Interactive, Batch and Command Procedure Execution

  > Use of Symbols and Logical Names

  > Tracking System Information

  > Error Handling

- There are many advanced functions not covered in this seminar, like the ability to integrate your commands into DCL; complete with help messages and error handling routines. If you look at the installation procedures for most software systems, they usually comprise a large amount of complicated DCL commands.



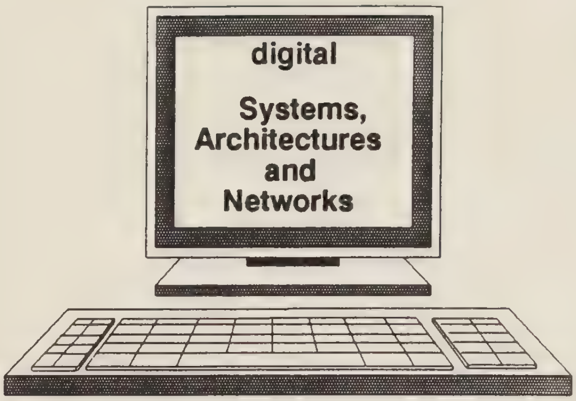
VMS DCL Commands

```
You can abbreviate any topic name, although ambiguous abbreviations
result in all matches being displayed.


Additional information available:

:=          =           @           ACCOUNTING  ALLOCATE    ANALYZE     APPEND
ASSIGN      ATTACH      BACKUP      BASIC       CALCULATE   CALL        CANCEL
CC          CDD         CDDL        CDDV        CDD_PLUS    CDO         CLOSE
CMS         CONNECT     CONTINUE    CONVERT     COPY        CREATE
DATATRIEVE  DEALLOCATE  DEASSIGN    DEBUG       DECK        DEFINE      DELETE
DEPOSIT     DICTIONARY  DIFFERENCES             DIRECTORY   DISCONNECT  DISMOUNT
DMU         DSCALC      DUMP        EDIT        ENCRYPT     EOD         EOJ
Errors      EXAMINE     EXCHANGE    EXIT        FDL         FMS         FORTRAN
GOSUB       GOTO        HELP        Hints       IF          INITIALIZE  INQUIRE
Instructions            JOB         Lexicals    LIBRARY     Line_editing
LINK        LOGIN       LOGOUT      LSEDIT      MACRO       MAIL        MERGE
MESSAGE     MMS         MONITOR     MOUNT       MULINET     NewFeatures _V44
ON          OPEN        PASCAL      PASSWORD    PATCH       PHONE       PRINT
PURGE       Queues      RDBVMS      RDO         READ        RECALL      RECOVER


Press RETURN to continue...
```



Logical Names

- Logical names are substitute names for a physical device, file specification, portion of a file specification, or another logical name.

- Logical names provide two primary functions:

  > file and device independence

  > file specification shorthand

- There are four logical names tables.

  > Process - Available to your process only

  > Job - Available to your process and any subprocesses

  > Group - Available to all users in your UIC group

  > System - Available to all users on the system

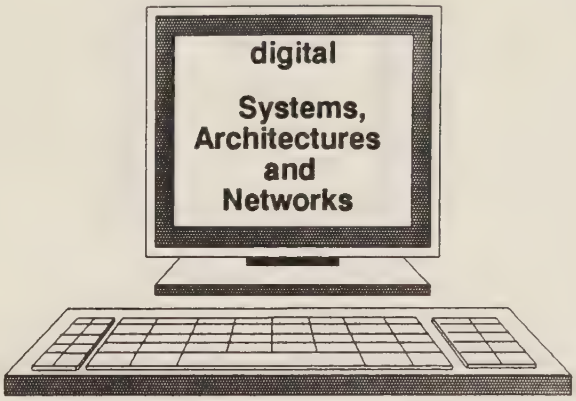
- VMS starts with the Process table, and continues with the Job, Group, and Systems Tables, in that order.

Examples of Logicals

- Logical names allow changes in the physical configuration of a system without changing the way a user or a program interacts with that system.

```
$ DEFINE DISK1 DUA1:
$ DEFINE ADDFILE DISK1:[SNELLEN]ADDRESS.DAT
```

- System defined logical names
  - > SYS$COMMAND - Initial stream to read input data. Defaults to terminal if interactive process.
  - > SYS$ERROR - Device where all errors messages will be displayed. Defaults to terminal if interactive, LOG file if batch.
  - > SYS$INPUT - Input stream read by command interpreter or programs. Defaults to terminal if interactive, batch stream if batch.
  - > SYS$OUTPUT - Output stream where any output will be written. Defaults to terminal if interactive, LOG file if batch.



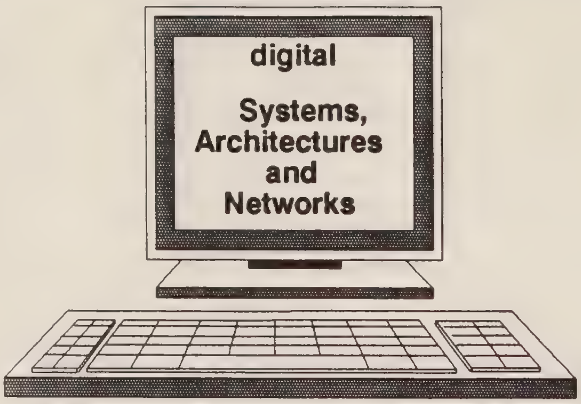
Show Logical/ALL

```
$ show logical/all
(LNM$PROCESS_TABLE)
"II_PIPESIZE" = "1504"
"LNK$LIBRARY" = "SYS$LIBRARY:VAXCRTL"

(LNM$JOB_806FB8F0)
"ING_TEMP" = "SYS$SCRATCH"
"SYS$LOGIN" = "CC190:[B89171]"

(LNM$GROUP_005600)
"AMTI" = "CC190:[B37873.DGTS.SENSOR.GPS]"
"ASERR" = "CC190:[B37873.DGTS.SENSOR.ASERR]"
"GRP_MANAGER" = "$1$DUA4:[GROUP.CC190]"

(LNM$SYSTEM_TABLE)
"ACP$BADBLOCK_MBX" = "MBA4:"
"ALW01_MI" = "DSCT10_ALW01$MI_PRINT"
"ALW01_SY" = "DSCT10_ALW01$SY_PRINT"
"ANLCVC_COMMON" = "$1$DUA1:[CVCCOMMON.]"
"ANLCVC_ROOT" = "$1$DUA5:[ANLCV1.]"
"ANLCVC_SYSTEM00" = "$1$DUA0:"
"ANLCVC_USER03" = "$1$DUA3:"
"ANLCVC_USER04" = "$1$DUA4:"
"ANLCVC_USER07" = "$1$DUA7:"
```



Symbols

- While logical names are usually used for devices, symbols are more like variables in a programming language. Symbols can hold logical values, character strings and numeric values.

- There are two types of symbols.

  > Local symbols operate at the current command level.

  > Global symbols are used for the whole job. You use a LOGIN.COM command file to create Symbols for use during your current session.

- Symbols usually are used to hold the results of user prompts, calculations or calls to lexical functions. Lexical functions return a wide variety of system, job and process information, plus have miscellaneous capabilities such as string manipulation.

- Example

```
$ value = (23 * (678 - 123))
$ show symbol value
VALUE = 12765   Hex = 000031DD  Octal = 00000030735
```

Lexical Functions

- Special functions that return process or system information. Can also manipulate user-supplied data. A lexical function is invoked by using the name with the correct number and type of parameters. There are over 30 lexical functions available. Some of the more popular ones are listed below.

  > F$CVTIME(input_time, output_time, field) - Converts absolute or combination time to the format "yyy-mmm-dd hh:mm:ss.cc".

  > F$EXTRACT(offset, length, string) - Extracts a substring from the given string.

  > F$GETJPI(pid, item) - Returns accounting, status and identification information on a specified process.

  > F$INTEGER(expression) - Returns the integer value of the specified expression.

  > F$LOCATE(substring, string) - Locates a substring in the given string and returns its offset. Returns length of string if substring not found.

  > F$TIME() - Returns the current date and time string.

Using Lexical Functions

- F$GETSYI(item, [,node]) - Returns status and identification information about the running system or about a node in the cluster. An example would be finding out which DECnet node you are logged on to. Uses that information to change your prompt from $ to nodename$.

```
$ NODE = F$GETSYI(NODENAME)
$ SET PROMPT = ""NODE’$"
MY_VAX$
```

- The above code fragment could be incorporated into the LOGIN.COM file, which is automatically executed upon login.

- Using Lexicals to Find File Information

```
MY_VAX$ TYPE WHEN_REVISE.COM
$!com file outputs data file last revised
$ Inquire file "Filename"
$ file$revise = f$file_attributes (file, "RDT")
$ show symbol file$revise

MYVAX$ @WHEN_REVISE
Filename: LOGIN.COM
FILE$REVISE = "15-APR-1988 14:05:15.61"
MYVAX$
```

Standard VMS Utilities

- **MAIL** - Allows you to send, receive, and store electronic mail. Mail is available through the DECnet network or can be exchanged with any other user on your VAX.

- **PHONE** - Allows you to "talk" with another use via the terminal and keyboard as you would a telephone. Can have a conference call with up to 5 other users.

- **HELP** - Gives you the DCL dictionary at your fingertips. Provides an explanation of every valid DCL command. Is also context sensitive when used inside MAIL or EDIT.

- **EDIT** - VMS provides three editors for working with text files. The standard EDIT editor can be used in either line or full screen mode. The Extensible VAX Editor (EVE) is used as a Text Processing Utility (TPU). Provides full screen word processing with word wrap, margin set, and other word processing capabilities.

- **BACKUP** - Used by system operators to backup system disks. BACKUP provides numerous qualifiers to select what to backup and to specify how it should be backed up.

Rdb

- VMS Version 5.1 includes the run-time Rdb license. Rdb is DEC's relational database management system (RDBMS).

- You will now a more consistent approach to distributed database applications. For example, you can build an application on one node and run the application from any other network node.

- It is likely that DEC will continue to integrate Rdb into the VMS operating system. This could have the effect of optimizing VMS for on-line transaction processing applications. It also puts DEC a leg up on its DBMS competitors.

- The run-time Rdb license is not as free as your DEC saleman will have you believe. You will still have to purchase a run-time H-kit and the documentation. Also any node used to build applications must have the full Rdb license.

- Most 3rd party DBMS will run on multiple platforms. For example, Informix, Ingres and Oracle will run on Sun's, Sequents, DECs, IBMs and a host of others. This is a major selling point for the 3rd party vendors.

Internals and Administration

- System Management Tools
- Memory Management Basics
- Four Internal Mechanisms
  - > Automatic Working Set Adjustment
  - > Swapper Trimmer
  - > Shared Memory
  - > CPU Scheduler
- Two Security Domains
  - > User Identification Codes
  - > Access Control Lists

VMS System Management Tools

- **MONITOR** utility. Shows current performance of system for a wide variety of resources (page faults, swap activity, direct and buffered I/O counts, process states). Can set parameters for how often sampling occurs. Then, writes results to a file for further processing.

- **ACCOUNTING**. Can take place at the SESSION or IMAGE level. Note the resource implications of tracking every image activation.

```
$ SET ACCOUNTING/ENABLE=image
```

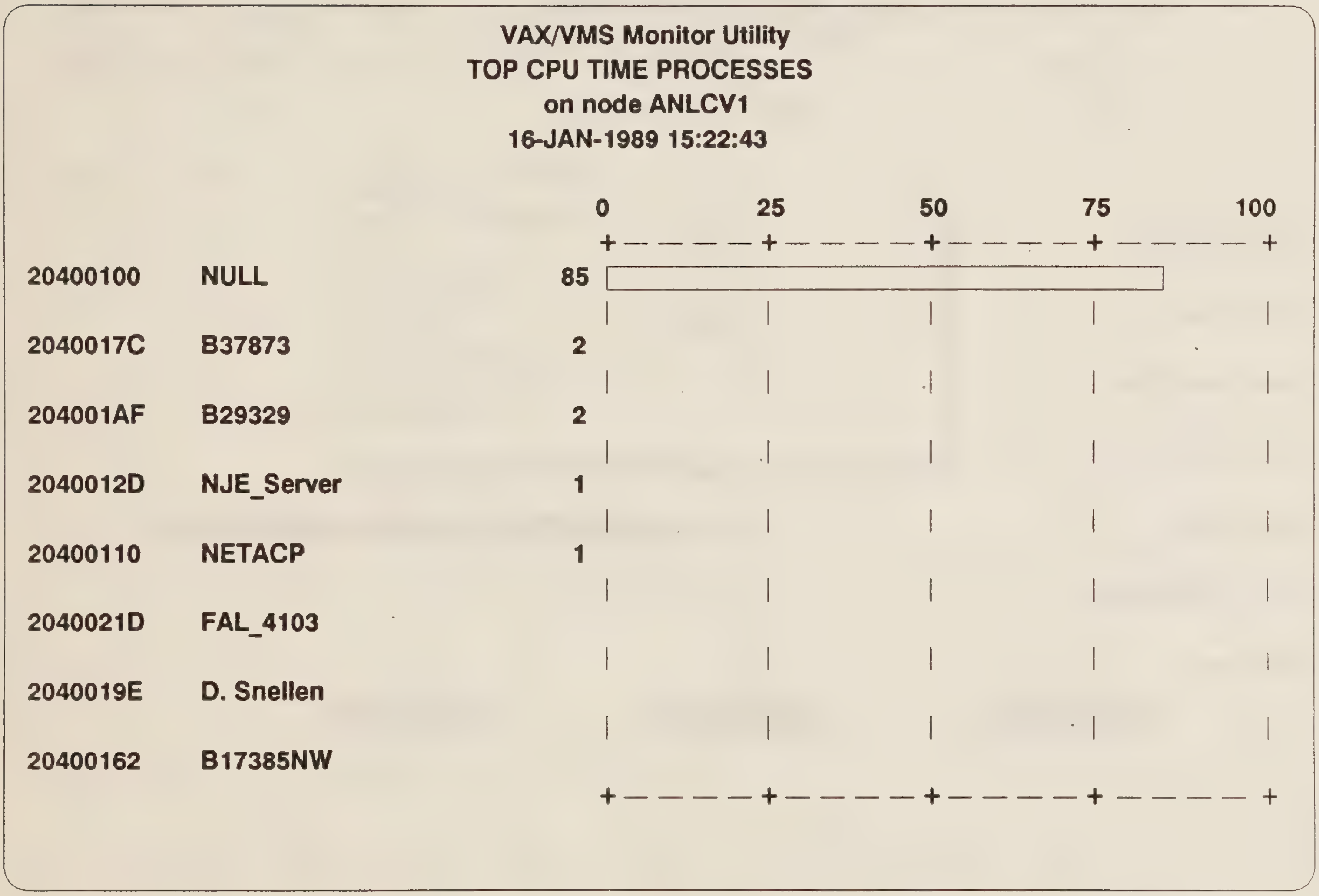
- The SYSGEN utility sets the overall system parameters.

- The AUTHORIZE program modifies the UAF.DAT file and changes individual session/process parameters.

- You can move the accounting/monitor data into a relational database for further processing: analysis of performance, predicting workloads, allocating system costs by users and groups.

- AUTOGEN.

Monitor Process/TOPCPU



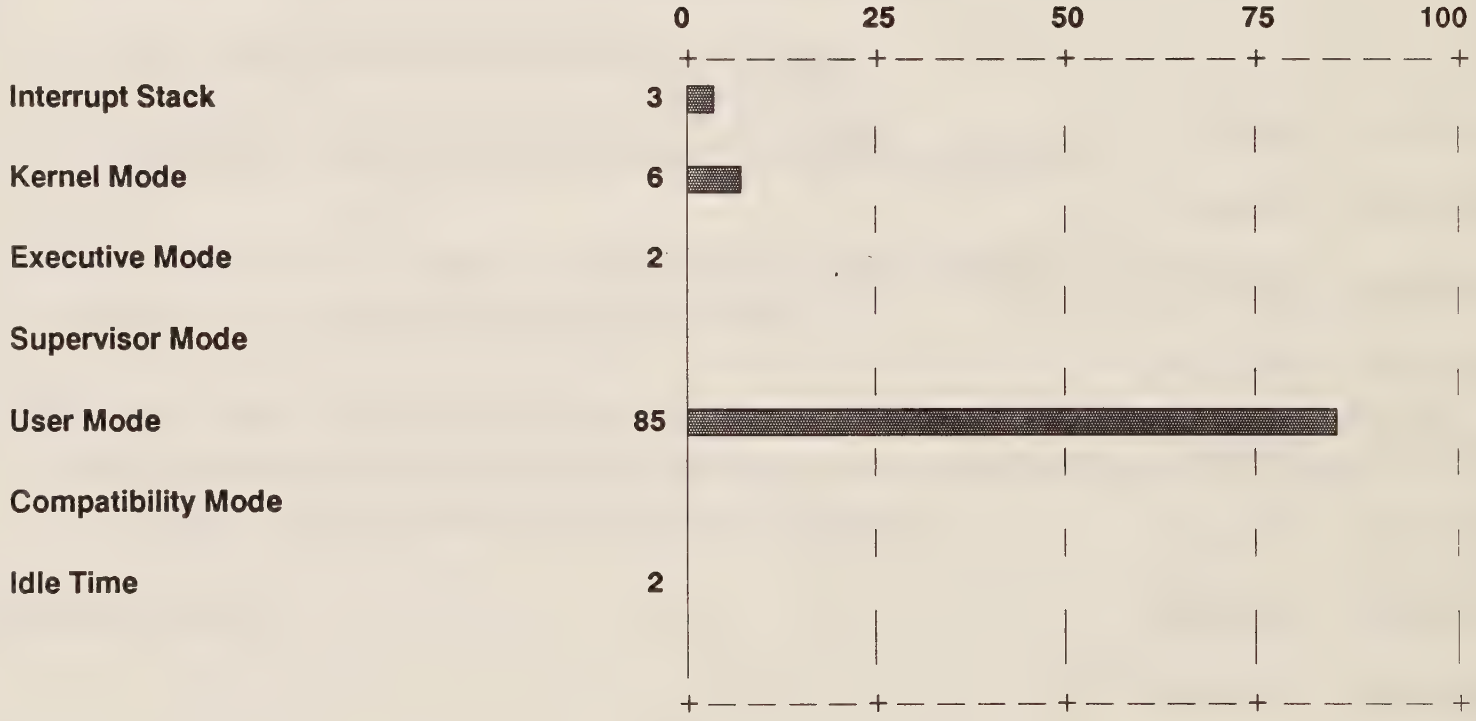
```
                       VAX/VMS Monitor Utility
                       TOP CPU TIME PROCESSES
                          on node ANLCV1
                       16-JAN-1989 15:22:43

                                  0        25        50        75       100
                                  +--------+---------+---------+---------+
20400100   NULL              85   |                                |
                                  |        |         |         |         |
2040017C   B37873             2
                                  |        |         |         |         |
204001AF   B29329             2
                                  |        |         |         |         |
2040012D   NJE_Server         1
                                  |        |         |         |         |
20400110   NETACP             1
                                  |        |         |         |         |
2040021D   FAL_4103
                                  |        |         |         |         |
2040019E   D. Snellen
                                  |        |         |         |         |
20400162   B17385NW
                                  +--------+---------+---------+---------+
```

Monitor Processes Modes

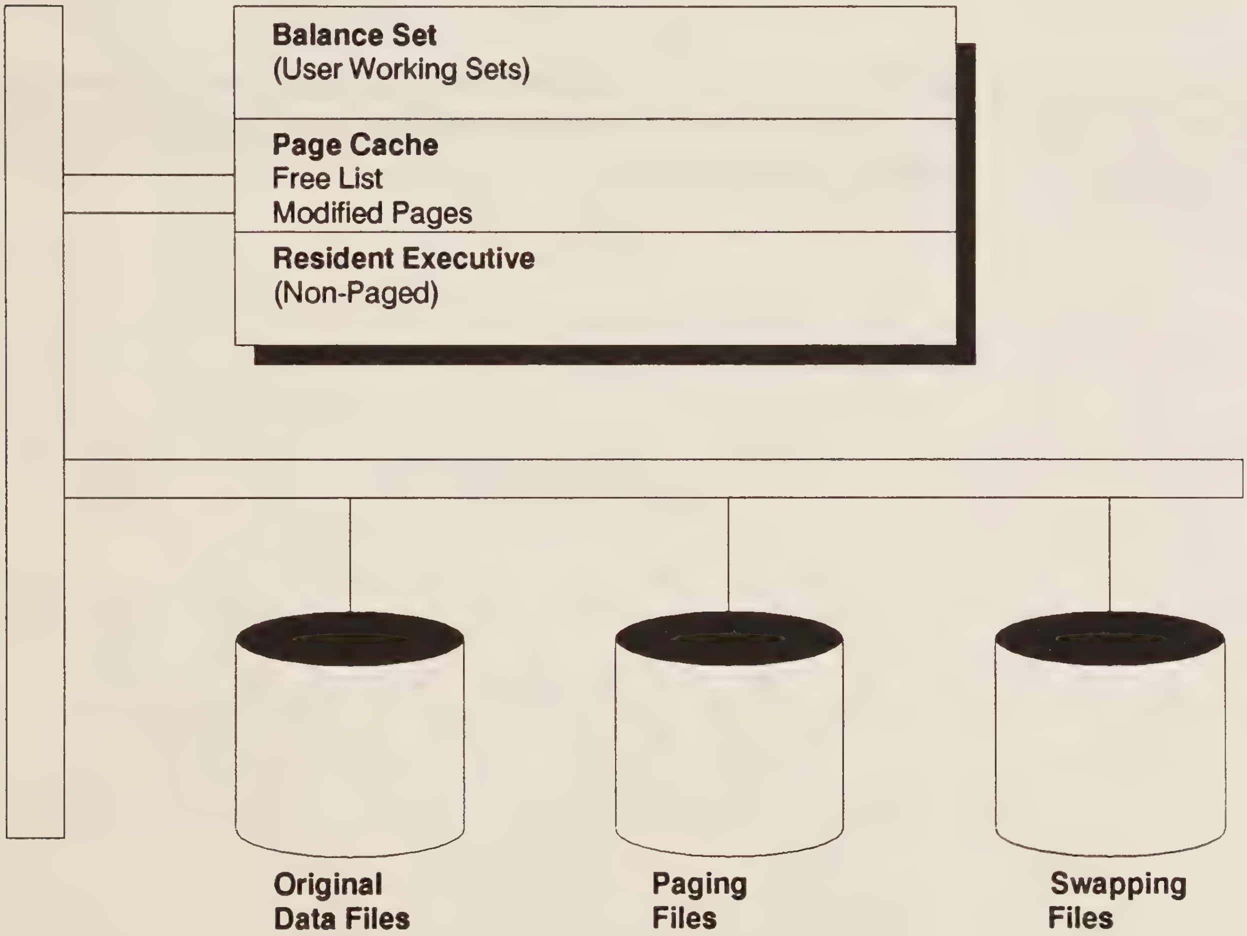
CUR

VAX/VMS Monitor Utility
TIME IN PROCESSES MODES
on node ANLCV1
26-JAN-1989 14:12:39



Memory

- Physical memory is divided into three pieces. The balance set has the area for processes to work in. The resident executive is non-paged dynamic memory. The page cache is used for transferring data coming from and going to disk. System disks provide auxiliary memory for paging, swapping, and storing programs.



Balance Set
(User Working Sets)

Page Cache
Free List
Modified Pages

Resident Executive
(Non-Paged)

Original Data Files

Paging Files

Swapping Files

Paging

- A page is the basic unit of memory management - 512 bytes. Each image or process has a number of pages. Those pages still in memory are called the working set.

- When a process requests a page, first look in working set. If not present, look for it in the page cache. If there, this causes a soft paging fault. If not there, look in the page file on disk - this a hard fault.

- Adding more paging files can reduce a bottleneck on file. Increasing the page cache may reduce hard faults but decreases available memory for working space in a finite environment.

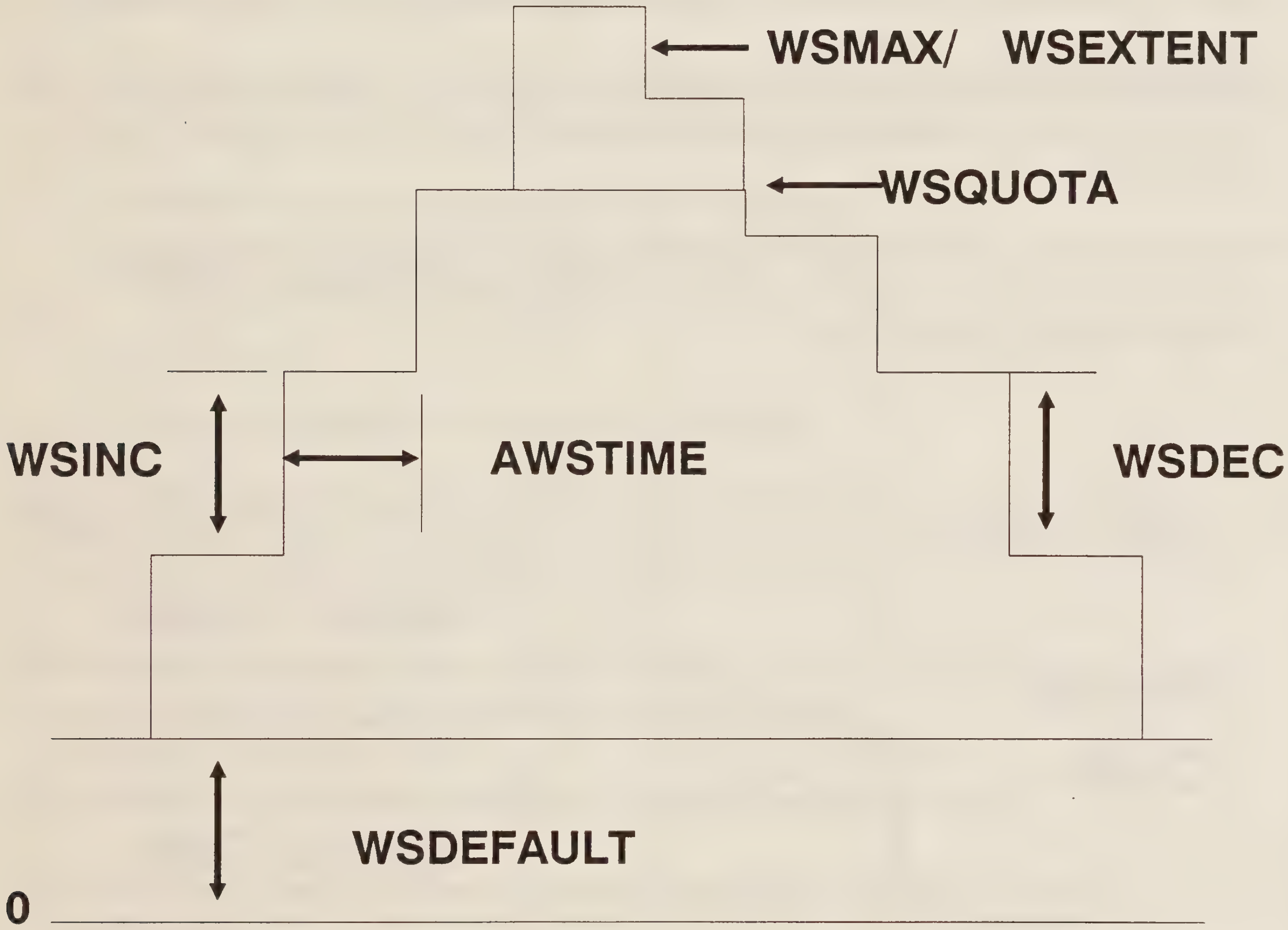
Four Internal Mechanisms

- Automatic Working Set Adjustment
- Swapper Trimming
- Shared Memory
- Scheduler

AWSA

- The following SYSGEN parameters affect the automatic working sets adjustments.
    - AWSMIN is the smallest size a working set can be adjusted down to.
    - AWSTIME is the amount of time, in 10 ms increments of CPU time, before a working set adjustment is made.
    - WSDEC is the number of pages the system will take away.
    - WSINC is the number of pages the system will give a process.
    - WSMAX is the absolute maximum number of pages a process working set may contain.
    - GROWLIM is the number of pages that must be in the free list before a process can borrow beyond WSQUOTA due to a pagefault.
    - BORROWLIM is the number of pages that must be on free list before a process can borrow beyond WSQUOTA due to a working set adjustment.
    - WSDEFAULT is the default number of pages a process begins with.
    - WSQUOTA is the number of pages a process may hold on to.
    - WSEXTENT is the number of pages a process can grow to if adequate memory is available.

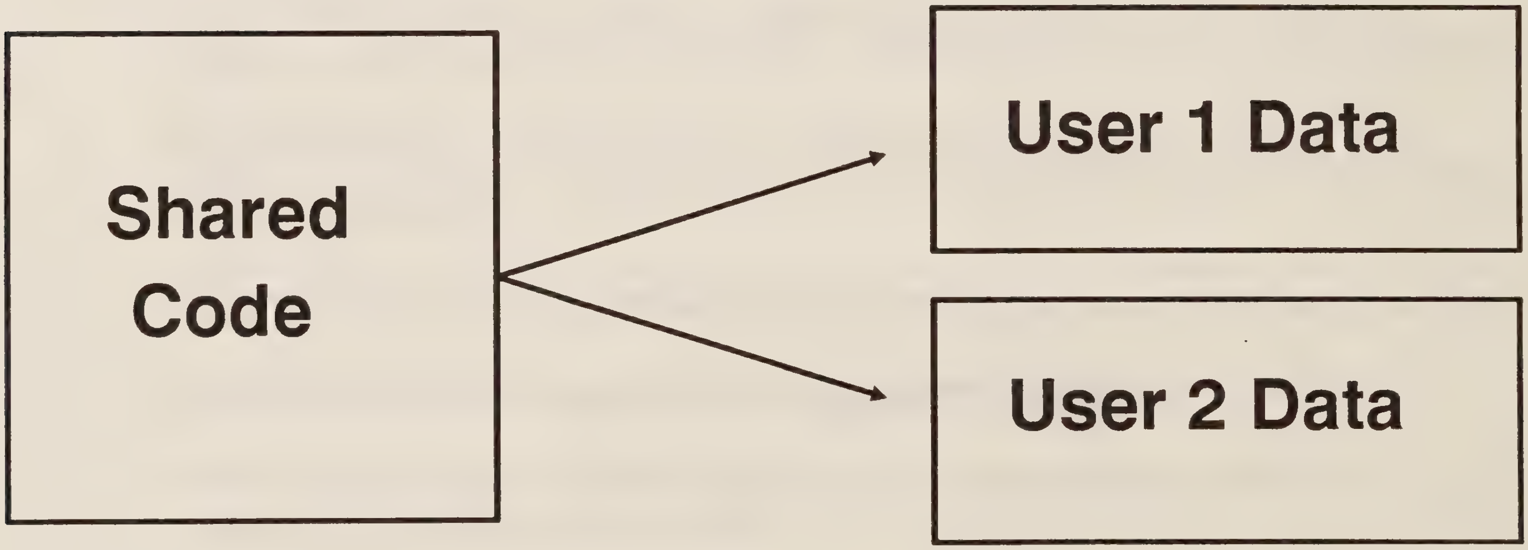
VMS Memory Management



[MEMUSAGE]

Shared Memory

- Savings only when there are several users simultaneously using the code. Otherwise, overhead greater than savings.
- SYS$SYSTEM:INSTALL will show the current and maximum shared access since installation. If maximum less than 3 or 4 users, not worthwhile.
- Increasing the global page table limits space available for individual processes. Images installed as shared are usually declared in the SYS$STARTUP procedure.


Shared Code

User 1 Data

User 2 Data

Scheduler

- Rotates control of the CPU among processes that are computable using a round-robin technique (time-slicing).
- Processes receive a change at computation based on their priority and state. They get the CPU until one of following occurs:
  - > Higher priority process becomes available.
  - > Enters a resource wait state.
  - > Finishes.
  - > System parameter QUANTUM elapses.
- If no other jobs of equal or higher priority available, can get another QUANTUM time-slice of CPU. As soon as one period elapses, priority decreases by one to give others a chance.
- Priorities range between 0 and 31. A priority over 16 gets precedence over the system - used for hardware interrupts.
- Priorities get boosted based on a complicated algorithm.
- Usually, all users will have the same priority, including system developers.

Monitor Processes

```
Process Count:     57          VAX/VMS Monitor Utility              Uptime:      8  22:56:11
                                     PROCESSES
                                  on node ANLCV1
                               26-JAN-1989 14:11:51

         PID      STATE  PRI    NAME            PAGES        DIOCNT   FAULTS   CPUTIME

      20800100    COM     0  NULL               0/0               0        0  08:58:03.5
      20800101    HIB    16  SWAPPER            0/0               0        0  00:03:41.4
      20800106    HIB     8  ERRFMT             0/137          7302       73  00:00:27.9
      20800107    HIB    16  CACHE_SERVER       0/128           191       60  00:00:00.2
      20800108    HIB    10  CLUSTER_SERVER     12/295            5      122  00:01:15.4
      20800109    LEF     7  OPCOM              0/194          2976    19765  00:00:24.5
      2080010A    HIB     9  JOB_CONTROL        0/402        185399      237  00:14:19.7
      2080010B    HIB    13  CONFIGURE          0/174             8      101  00:00:00.0
      2080010C    LEF    15  RDMS_MONITOR       0/76             13     6221  00:00:00.2
      2080010D    HIB    13  RPC$SWL            10/224            8      117  00:00:00.1
      2080010F    HIB    10  NETACP             0/456           429      461  00:38:15.3
      20800110    HIB     8  EVL                1/87             43   212845  00:00:06.2
      20800112    HIB     9  DMFRCPB6           0/881          3929      256  00:00:07.1
      20800113    HIB     9  DMFACPB6           0/482            10      133  00:00:00.3
      20800114    HIB     9  REMACP             0/96              2       83  00:00:01.3
```

Security and Control

- A combination of being able to control access and use of resources as well as being able to monitor and account for the use.

- Security on your system is only as good as the physical security of the CPU. Access to the cabinet or operator console allows anybody to have access to any routine. Physical security becomes an issue in distributed networks with MicroVAXes in non-secure environments. Big machines are usually stored in a fairly secure machine room environment.

- Accounting is essential to track what is occurring. The ACCOUNTING and MONITOR utilities, along with LEXICAL functions provide a rich base of raw data for monitoring resource activity.

- DEC has developed a product called VAX Secure Kernel that has received an A1 security rating from the National Security Agency's National Computer Security Center (NCSC). Runs under VMS and Ultrix as a system-level layer. This is an unreleased product.

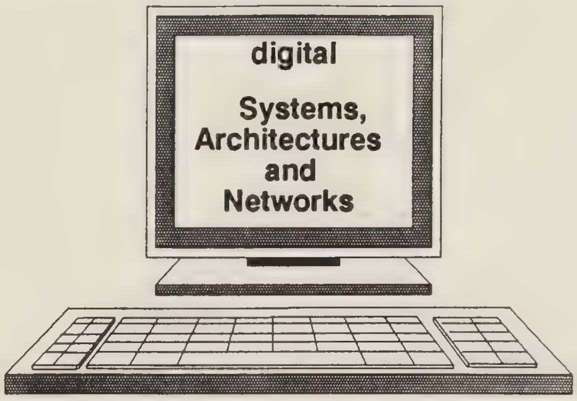
- DEC's other security package is called VAX Security Enhancement Service (SES). It is currently being evaluated by NCSC for a B1 rating.

Logging In

- This is the most sensitive time for security on a system. Login can occur from a variety of different sources.

> LOCAL	User on a directly wired terminal
> DIALUP	User on a modem
> REMOTE	User comes in over a network
> BATCH	Batch jobs activates
> DETACHED PROCESS	Not connected with a user
> SUBPROCESS	Spawned subprocess returns to main job

- The system tracks and displays the time of the last successful interactive login, the last non-interactive login and the number of login failures since the last successful one.



Passwords

- VMS uses a one-way encryption algorithm. This means that, short of guessing, there is no way you can determine a password.

- System passwords are used to secure the terminal. A system announcement or any sort of reaction to indicate that there is a computer connected to the terminal is suppressed until the system password is successfully entered. This is most often used on dial-up lines.

- User passwords are used to initiate a login for a user. A few accounts are OPEN - this is highly discouraged. Make sure that you change the user passwords for all the generic accounts that DEC ships with a new VAX. SYSTEM and FIELD are two such generic accounts.

- Users can change their passwords with the SET PASSWORD command. Password aging can force users to change their passwords on a regular basis. The LOCKPWD flag in a user authorization entry prevents users from changing the password.

- Accounts can have two passwords: a primary and a secondary. Both must be entered to activate the account.

Password Grabber

```
$ type mystery.com
$ OPEN/APPEND FILE MYRECORD.LOG
$ ON CONTROL_Y THEN GOTO EXIT:
$ TOP:
$ @clear !User Written Clear Screen
$ TYPE SYS$INPUT "TRANSFINANCE NODEA - Login Please"
$ INQUIRE P1 "Username"
$ INQUIRE P2 "Password"
$ WRITE FILE P1+" "+P2
$ TYPE SYS$INPUT "System Inactive - Try Again Shortly"
$ GO TO TOP
$ EXIT:
$ CLOSE FILE
$ @CLEAR
```

- Watch out for these. In a campus environment, they occur with regularity!

Login Failures

- Expired accounts can cause a login failure. Expiration dates are optionally set with the AUTHORIZE facility. Login class restrictions prohibit some users from setting host to remote nodes or to login via a modem.

- Shift restrictions set certain hours as primary and others as secondary. Users can be prohibited from processing during these times. This applies to batch jobs too!

- Evasive action. If there are enough login failures at a particular terminal location, the system begins taking evasive action and won't let anybody on that terminal. This is accompanied by an alarm to a file or an operator console.

File Protection Mechanisms

- Two different mechanisms exist: Access Control Lists (ACL) and User Identification Codes (UIC).

- Each user gets an individual UIC and a group UIC. The combination of the two provides a unique identifier for every user on that node.

- Every object (file, directory, volume) has a UIC protection allowing READ, WRITE, EXECUTE, or DELETE privilege to SYSTEM, WORLD, GROUP and OWNER.

```
$ SET PROT =(S:RWED,O:RWED,G:R,W:)file dat
```

- System first checks UIC protection. If that doesn't allow access to the object, ACLs are checked.

- If the SYSTEM does not have read and write privileges to a directory, programs such as electronic mail and backup procedures may not function properly.

ACLs

- New in Version 4 of VMS. This is a more granular and powerful system than the UIC system. It requires more management and is optional.
- ACLs can be established for different objects including devices, logical name tables, directories and files.
- Users are identified in a list for each ACL. Users can be identified by UIC, whole groups ([20,*]), system defined classes (LOCAL), or a general identifier mechanism used to put people into broader groups than UICs (ACCOUNTING).
- ACLs can include an alarm which will write out a log entry to a file or operator console. Log entries can be based on the success or failure of a given access.
- ACLs can be set up to propagate protection down to files with a directory. This ensures a consistent level of security at lower levels of the file hierarchy.

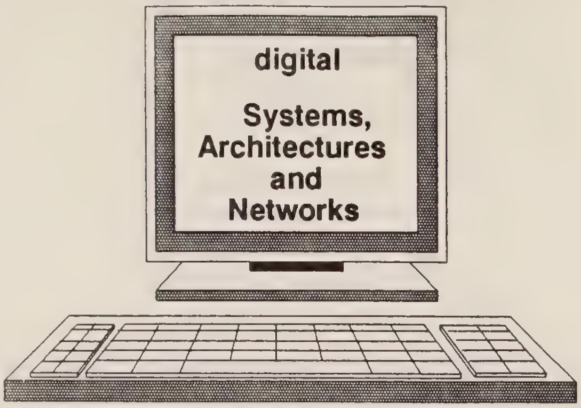
User Privilege

- VMS, as opposed to Unix, has a very granular protection structure.

TYPE	Privilege	Description
Normal	MOUNT	Mount volume
	NETMBX	Network connection
	TMPBBX	Create temporary mailbox
Group	GROUP	Group file access
	GRPPRV	Control processes in a group
Devour	ACNT	Disable accounting
	EXQUOTA	Exceed disk quota
	SHMEM	Create shared memory structures
System	ALTPRI	Change priorities
	BYPASS	Bypass object protection
	OPER	Execute operator functions
	WORLD	Control any process
	SHARE	Access allocated device
	SYSLCK	Lock system-wide resources
	SETPRV	Enable any privilege

Audits

- Following events can be audited:
  - > Access to Files, Use of Privilege to Access Files
  - > Image Installation
  - > Login, Logout, Breakin Attempts
  - > Changes to Passwords
  - > Volume Mounts/Dismounts
  - > Modification of Rights DB
- It is also possible to audit every keystroke at a particular terminal session.
- The normal accounting log keeps track of start time, stop time, CPU usage by job. Accounting can be enabled optionally at the image level, for all images or selected ones.



VMS v. Ultrix: User Interfaces and Tools

- It is important to distinguish between the "raw" user interface, such as DCL or a C-Shell and applications built on the facilities of the operating system.

- Ultrix has a very sophisticated set of tools available for software development. Many of these are available in the VMS environment, but often in a less powerful form. Because of this, Unix is very good for building sophisticated information systems.

- For the naive operating system user, VMS is probably an easier system to work with. The hierarchical help system and the more English-like command language contribute towards a friendlier atmosphere.

- For the system programmer, the Unix tools seem to provide a sophisticated ability to modify the system and create new utilities.

- In both cases, sophisticated windowing environments make much of the operating system transparent to the user.

VMS v. Ultrix: System Administration

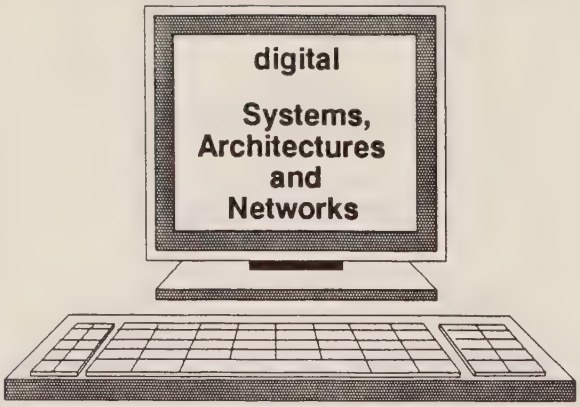
- Security. Unix has one account with system privilege called "root". The concept of a granular privilege structure allocated among multiple users is foreign to the Unix environment. In addition, the file security mechanism resembles the traditional UIC-based mechanism in VMS.

- There is a secure version of Unix that has been developed by Gould. AT&T is also working on a secure Unix. Many observers doubt that a secure Unix will still retain the essential features that characterize the operating system.

- Performance Management. Tuning and auditing is possible on an Ultrix operating system, but require a higher degree of skill. VMS systems tend to have a larger set of tools for monitoring and diagnosing system problems.

- Administration. VMS seems to be easier to administer, in general. This is probably because of the better documentation set and several key utilities that have been developed for managing user accounts.

- The differences between the operating systems are minor compared to the problem of training users and system staff.



Key Concepts in This Section

- Three families of Unix. The AT&T System V branch of Unix, the Berkeley/Ultrix version and IBM's AIX. Currently, its anybodys guess which version will dominate the market. Hopefully, a peasefully coexistance will emerge.

- DCL has a variety of features that make it a powerful user interface. Command procedures allow the construction of complex installation scripts for software.

- Just as important as the sophisticated features, DCL has a strong help facility. Most software systems use a similar style of computing based on the VT100 keypad.

- The AWSA and other internal mechanisms have a great deal of flexibility for adjustment. Tuning the responsiveness of the AWSA can greatly increase response time on VAXes.

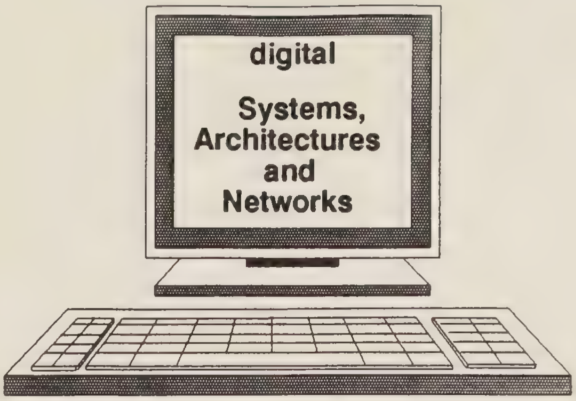
- Security can be accomplished either through the ACL or the UIC protection mechanisms. ACLs allow a variety of alarms to be set up based on either success or failure of a control.

"Basically, money is not a big factor in [Washington]. It isn't thought about as it is in other cities. What counts is position and power."

Preston Robert Tisch, retired Postmaster General

VAXclusters

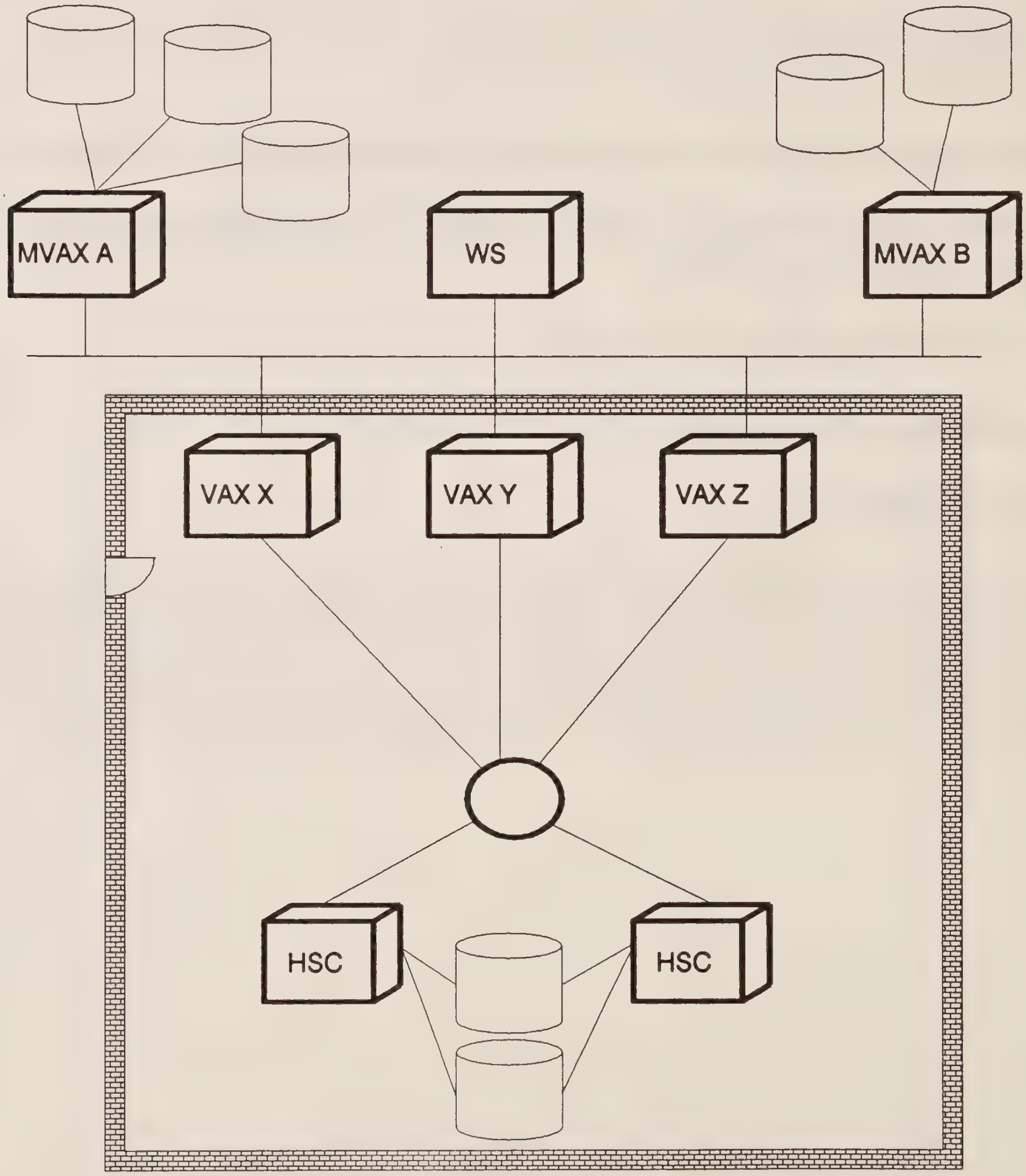
VAXCLUSTERS



Overview

- Clustering provides a unified management domain and view of a file system for a group of separate computers.
  - > Not a parallel processor because of the absence of shared memory.
  - > Unified file system and management domain differentiate a cluster from a traditional LAN.
- Two key advantages of clusters are
  - > scalable performance
  - > high availability
- Three kinds of clusters exist. A high speed computer-room cluster works only for Unibus and VAXBI bus machines. A Local Area VAXcluster (LAVC) performs the same services over a significantly slower Ethernet. And a hybrid that can integrate a LAVC with the computer room.

VAXcluster Configurations



Components of a VAXcluster

- > Cluster Software
- > Processors
- > Storage devices and controllers
- > Interconnects

VAXcluster Software

- System Communication Servers (SCS) - provides a software layer for internode communication.

- Connection Manager - builds on top of SCS to define and coordinate VAXClusters. Manages a quorum system to decide when the Cluster should be reformed.

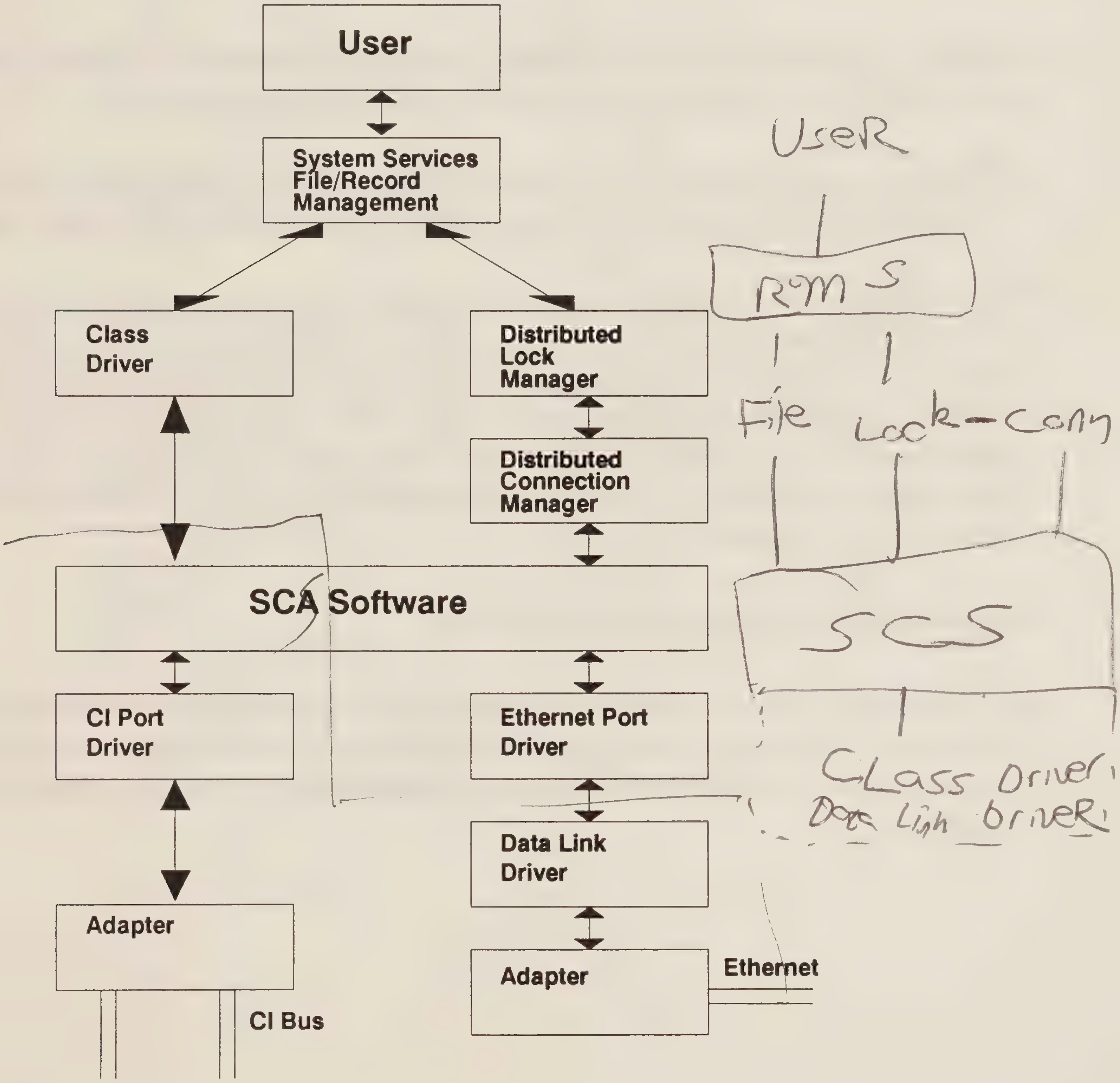
- Distributed File System - allows access by multiple CPUs to RMS files.

- Distributed Lock Manager - allows queuing and locking of resources including files and devices.

- Distributed Job Controller - distributes work among logical names to specific queues for printing and batch jobs.

- Mass Storage Control Protocol Server - implements the MSCP protocol which is used on HSC disks to allow locally connected disk drives to be accessible cluster-wide. Runs in both clustered and unclustered environments. MSCP has no knowledge of the VAXcluster environment.

VAXcluster Software



Connection Management

- Cluster membership is a dynamic process. A node may abort, but cluster processing on other nodes should usually keep on going.

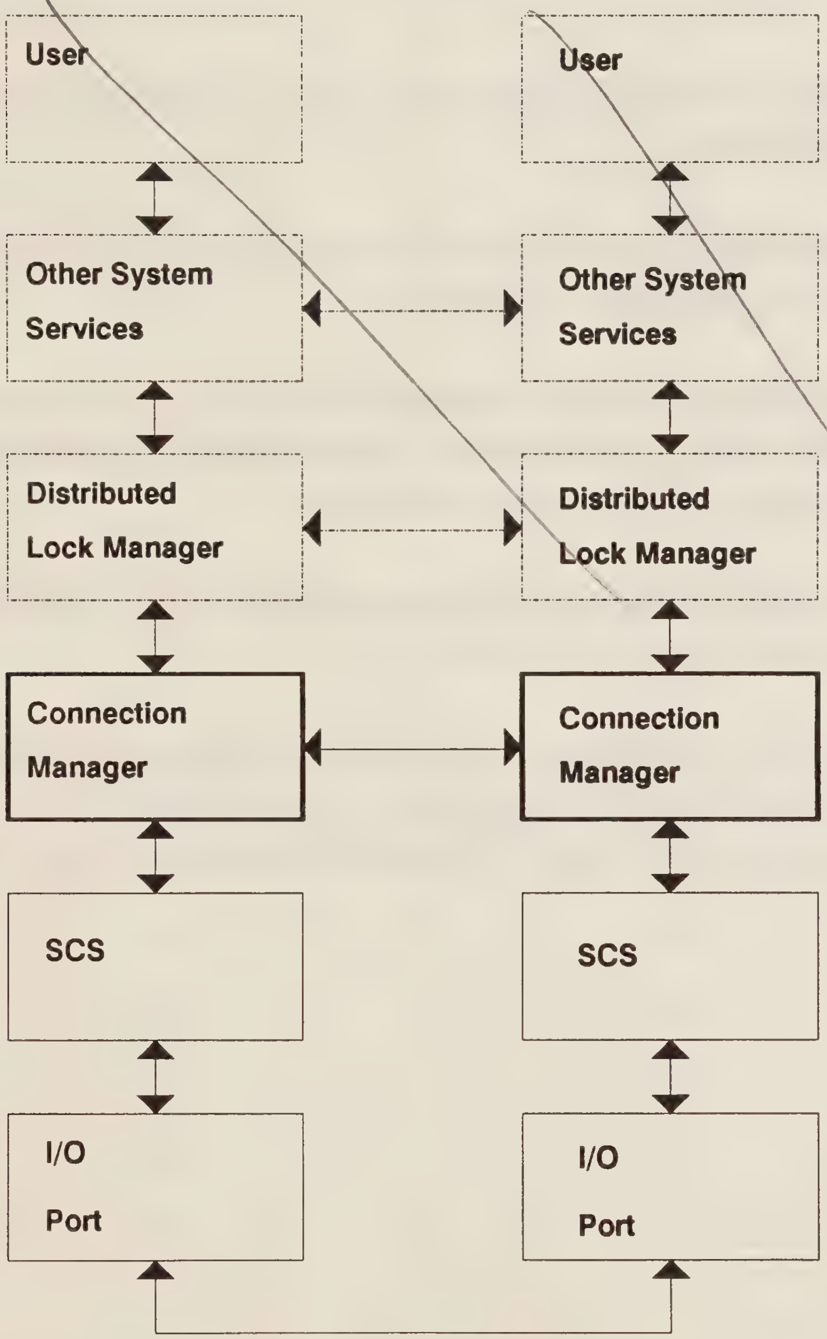
- When one node leaves the cluster, if the cluster is still intact, all locks are released allowing the other nodes to gain access to resources.

- The connection manager uses a quorum system to decide if there is still an operational cluster. Each node has a SYSGEN parameter, VOTES. There is a cluster-wide parameter called EXPECTED_VOTES. During state changes, the connection manager evaluates the votes and determines if a cluster is still intact. If not, all cluster processing and I/O on cluster-accessible disks is suspended until enough votes exist to form a new cluster.

- A quorum has to be greater than half.

- A QUORUM disk can produce increased availability (particularly in small clusters). This disk has a file, QUORUM.DAT, which must be accessible to all nodes. The file operates as a virtual node, voting to stay in the cluster.

Connection Management


User

Other System Services

Distributed Lock Manager

Connection Manager

SCS

I/O Port

User

Other System Services

Distributed Lock Manager

Connection Manager

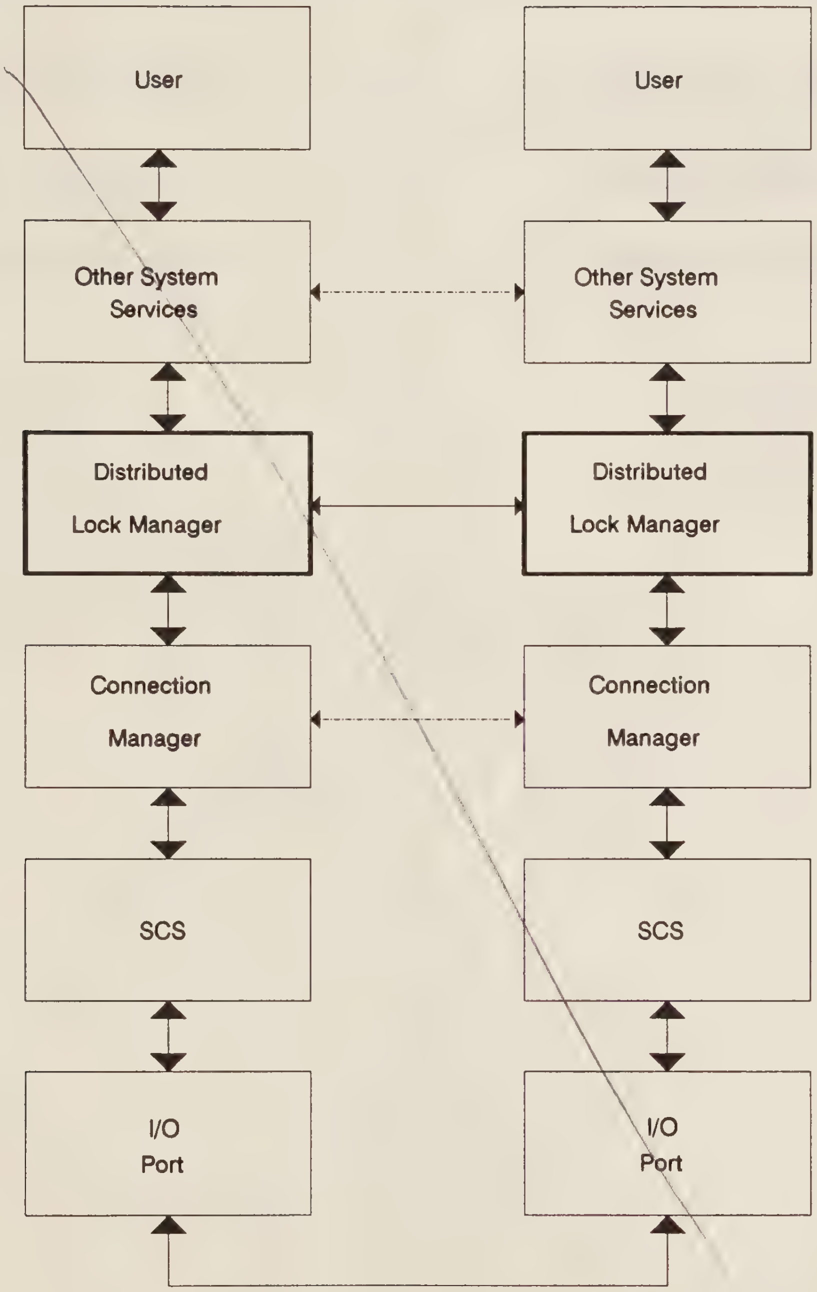
SCS

I/O Port

Data Management

- The ability to have multiple processors share storage resources is a core feature of a VAXcluster.
- Distributed data management, for the most part, is handled by the software and is transparent to the user.
- The processes running on the multiple CPUs share data by applying locks to volumes, files and records. Processes can have either an exclusive or shared I/O lock on a resource.
- The distributed lock manager is responsible for synchronized read and write resource sharing in the cluster.
- The distributed lock manager maintains a database of locked resources and which node is managing the lock. If a resource is not locked, the first requesting node becomes the lock manager for that resource.

Distributed Lock Manager

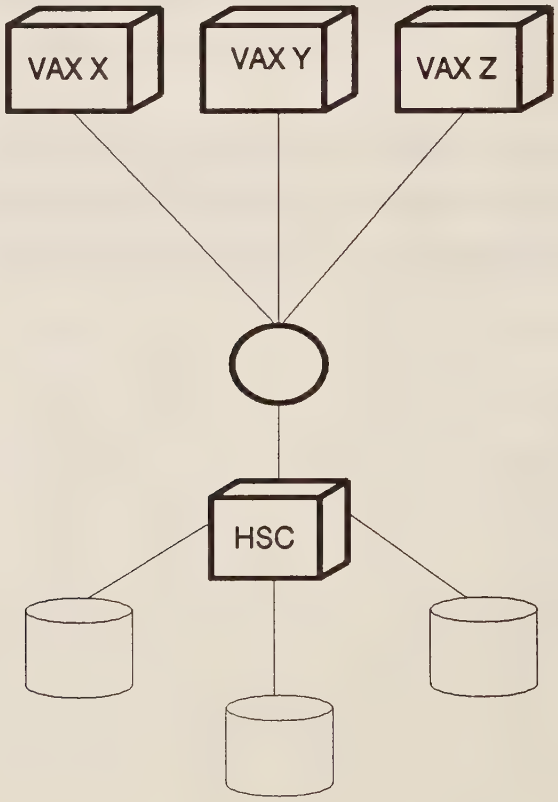


[DISTMGR]

Distributed Job Controller - Batch Queue

- Two types of batch queues
  - > Generic batch queue
  - > Specific batch queue

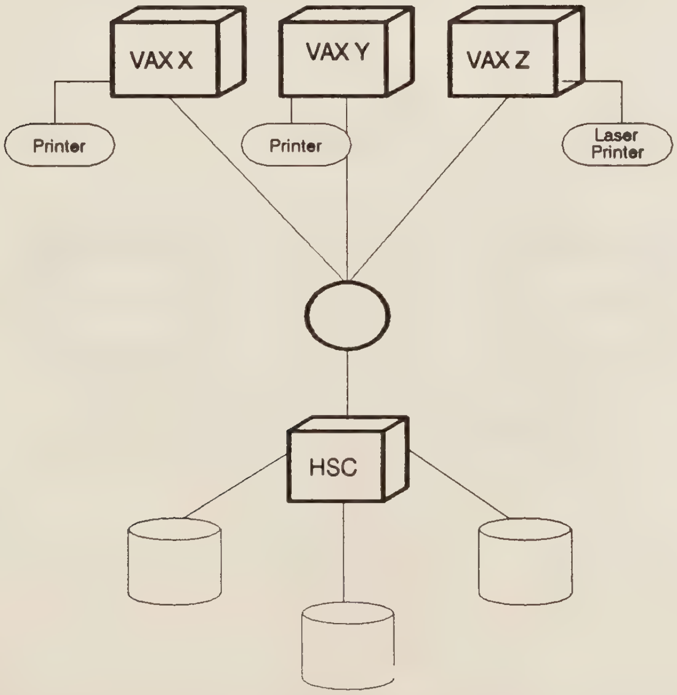
```
$ SUBMIT JOB-A
$ SUBMIT JOB-B
$ SUBMIT JOB-C
```



Distributed Job Controller - Print Controller

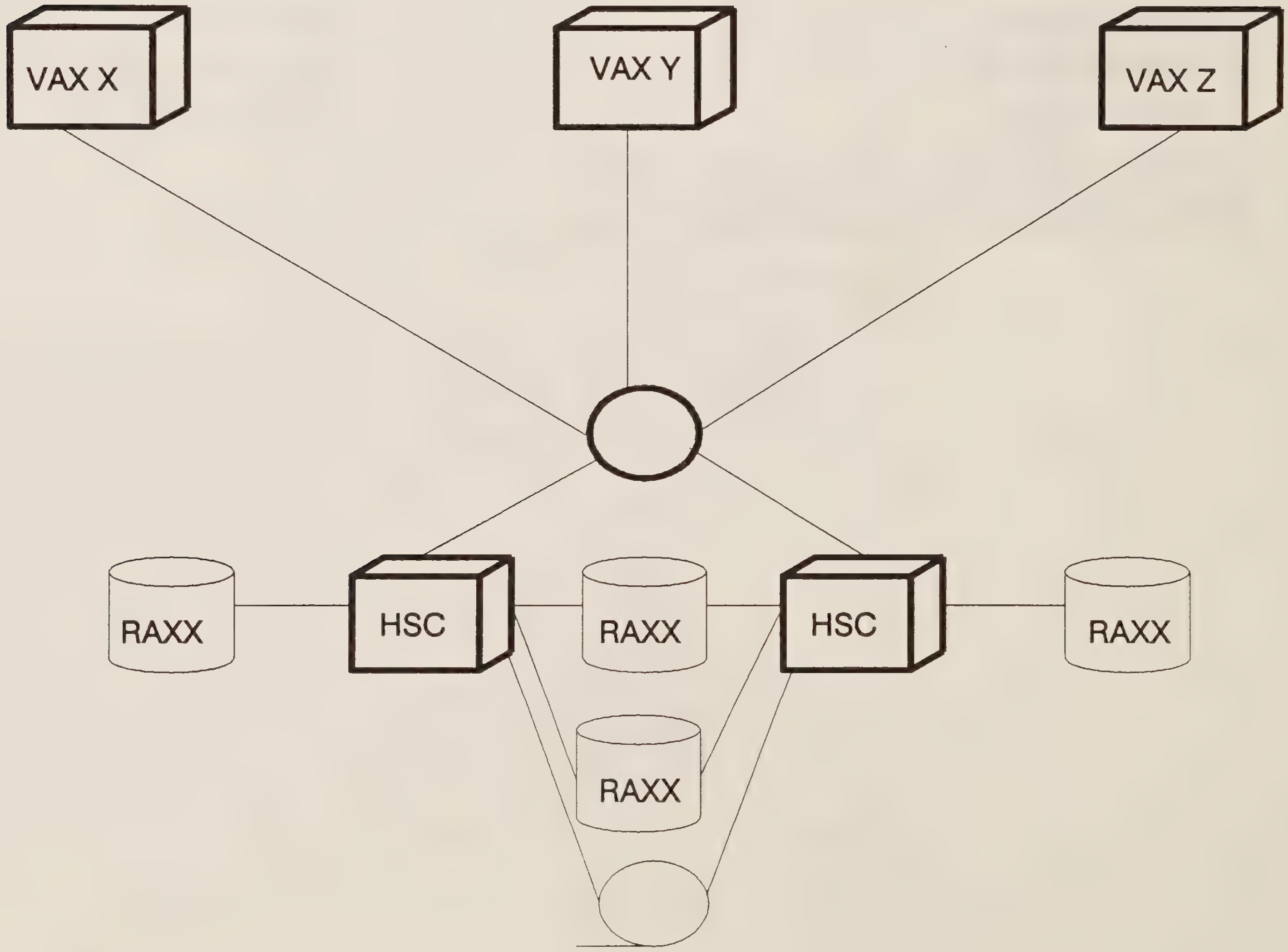
- Two types of print queues
  - > Generic print queue
  - > Specific print queue

```
$ PRINT JOB-A
$ PRINT JOB-B
$ PRINT JOB-C
$ PRINT/QUEUE LASER$PRINT JOB-D
$ PRINT/QUEUE LASER$PRINT JOB-E
```



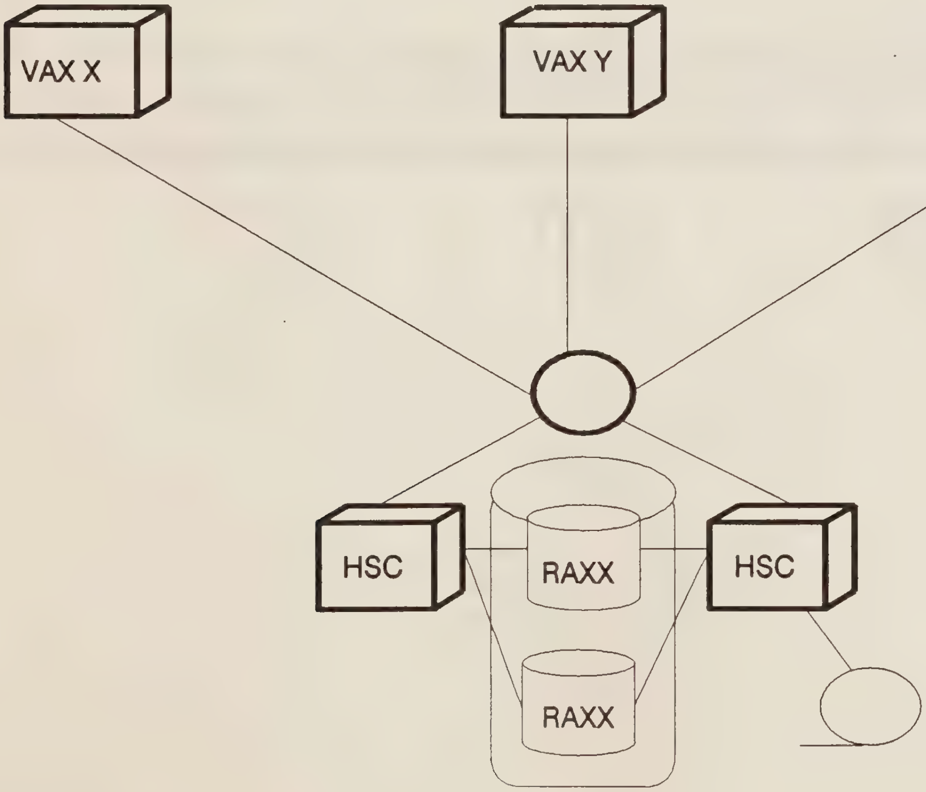
Dual Porting

- **DSA drives and tape devices can be physically connected to two HSC controllers. Should a HSC fail, the disks automatically failover to the remaining HSC. DSA drives can also be dual ported between processors with the same failover capability.**



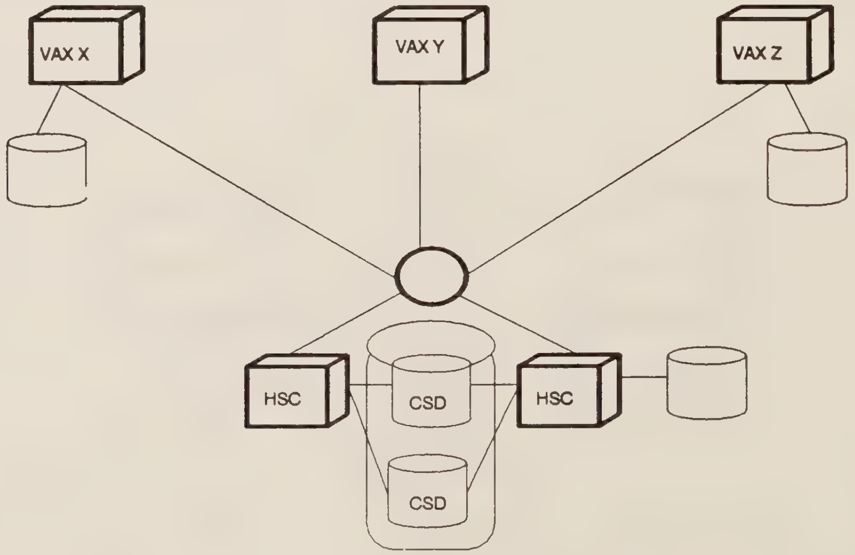
Volume Shadowing

- Volume shadowing is recording data on one or more compatible physical disks. The physical disk would then be known as a volume set.
- Once created, users and software view the volume set as a single virtual disk. Should one of the physical disks fail, processing continues on the remaining disks. This failover is transparent to the user.
- Performance can be enhanced because data reads can occur on any disk within the volume set.



Common System Disk

- Having a common system disk allows two or more processors to boot and use the same physical disk.
- With a common system disk, the cluster can be managed as a single processor.
  - > Have the same processing environment.
  - > Access to data/images can be restricted.
  - > Changes to environment (i.e. new accounts) only need to be made once.
  - > Software updates and installation done once.
- A common system disk is a candidate for volume shadowing.



Cluster Types

- Homogenous clusters
  - > Identical User Accounts.
  - > Same installed images.
  - > Same logical name tables.
  - > Mass storage devices and queues are shared.
- Heterogenous clusters share some devices and data. Used when workload characteristics differ but common access to data needed.
- Usually, a cluster will be someplace in between heterogenous and homogenous types. Some resources will be duplicated, while other resources will reside only on particular nodes of the cluster.

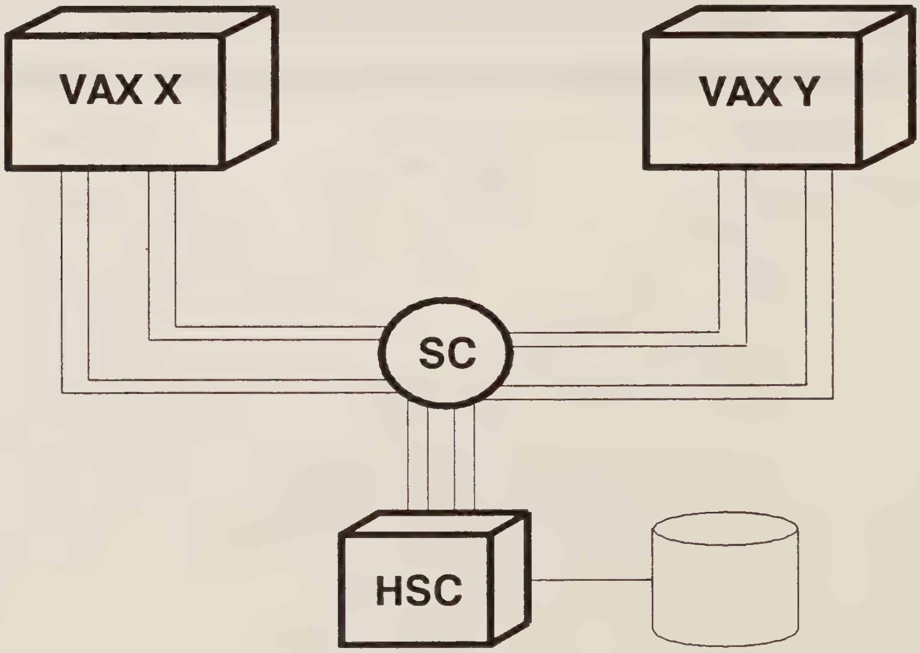
Computer Interconnect

- The Computer Interconnect (CI) is a high speed, fault tolerant, dual-path connection between all cluster nodes. The CI operates at 70 Mbits/s.

- A node is either a VAX processor or a HSC. The CI allows up to 24 nodes in any combination of processors and HSCs.

- The processors use a CI adapter to connect to the CI bus. The CI bus is two pairs of cable. Each pair has a transmit and receive cable. Both sets are normally used. Failover is automatic.

- The star coupler is the common connect point for all CI nodes. The star coupler is a passive device.

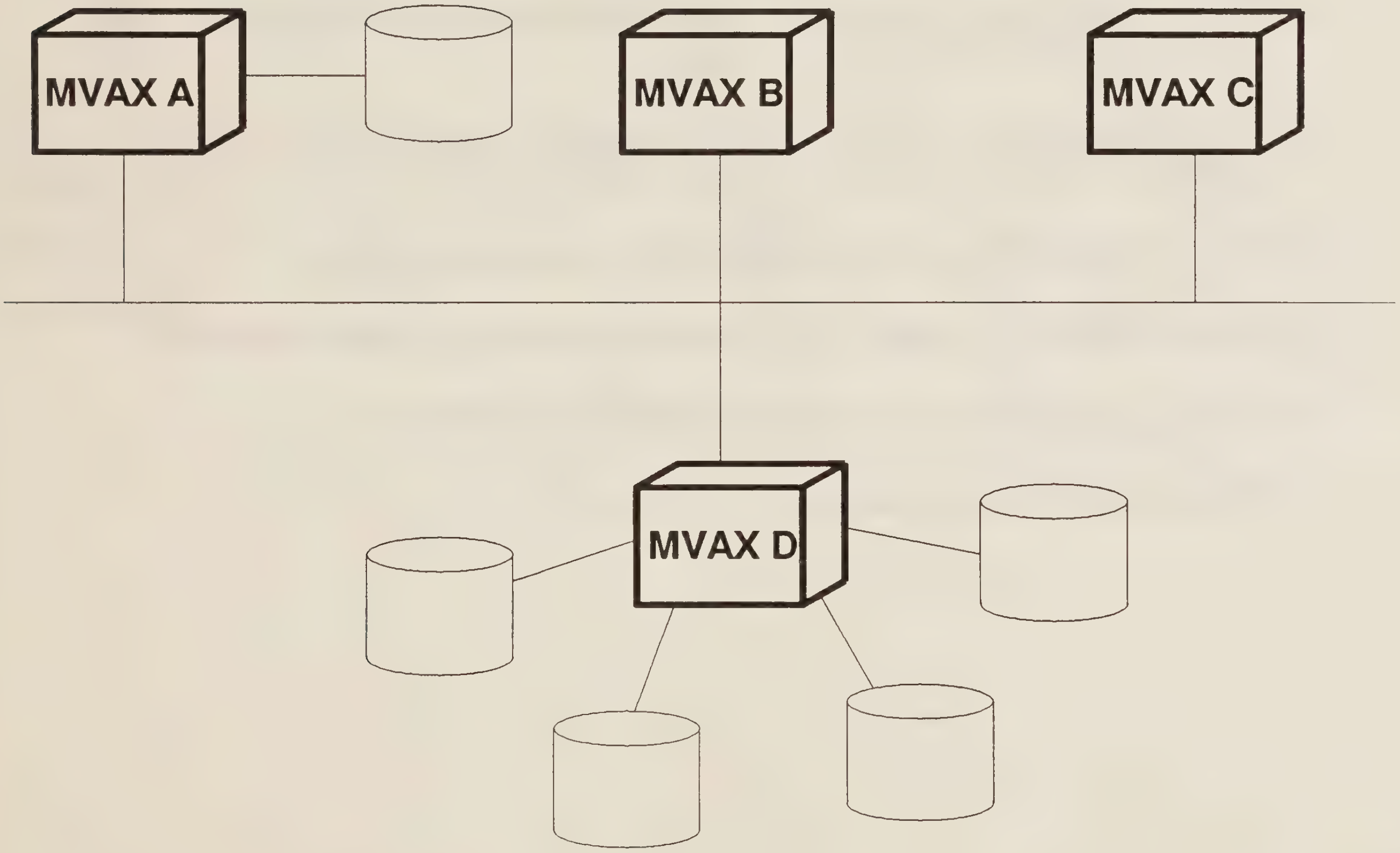


Network Interconnect

- The Network Interconnect (NI) is used for Local Area VAXcluster (LAVC) configurations. The ethernet cable, itself, becomes the bus.

- The VAXcluster software and function is the same. The NI operates at 10 Mbits/s.

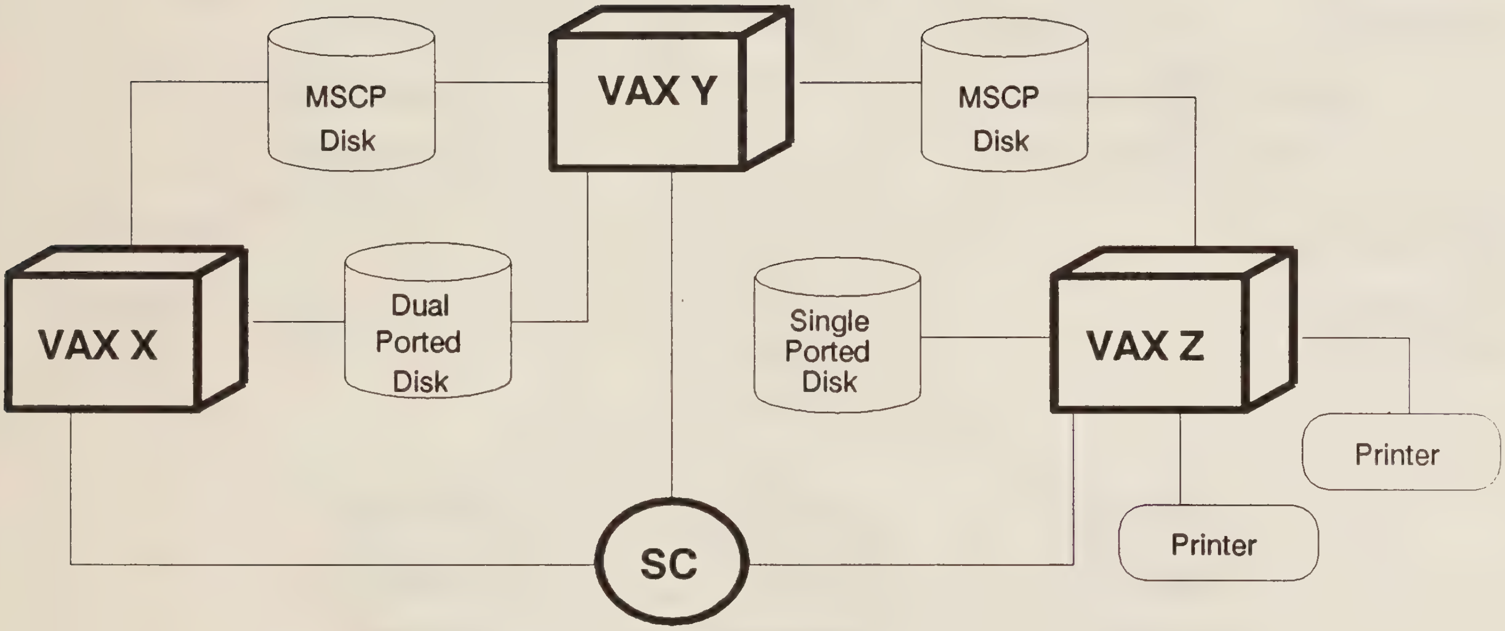
- The NI allows up to 26 nodes to participate in the LAVC.



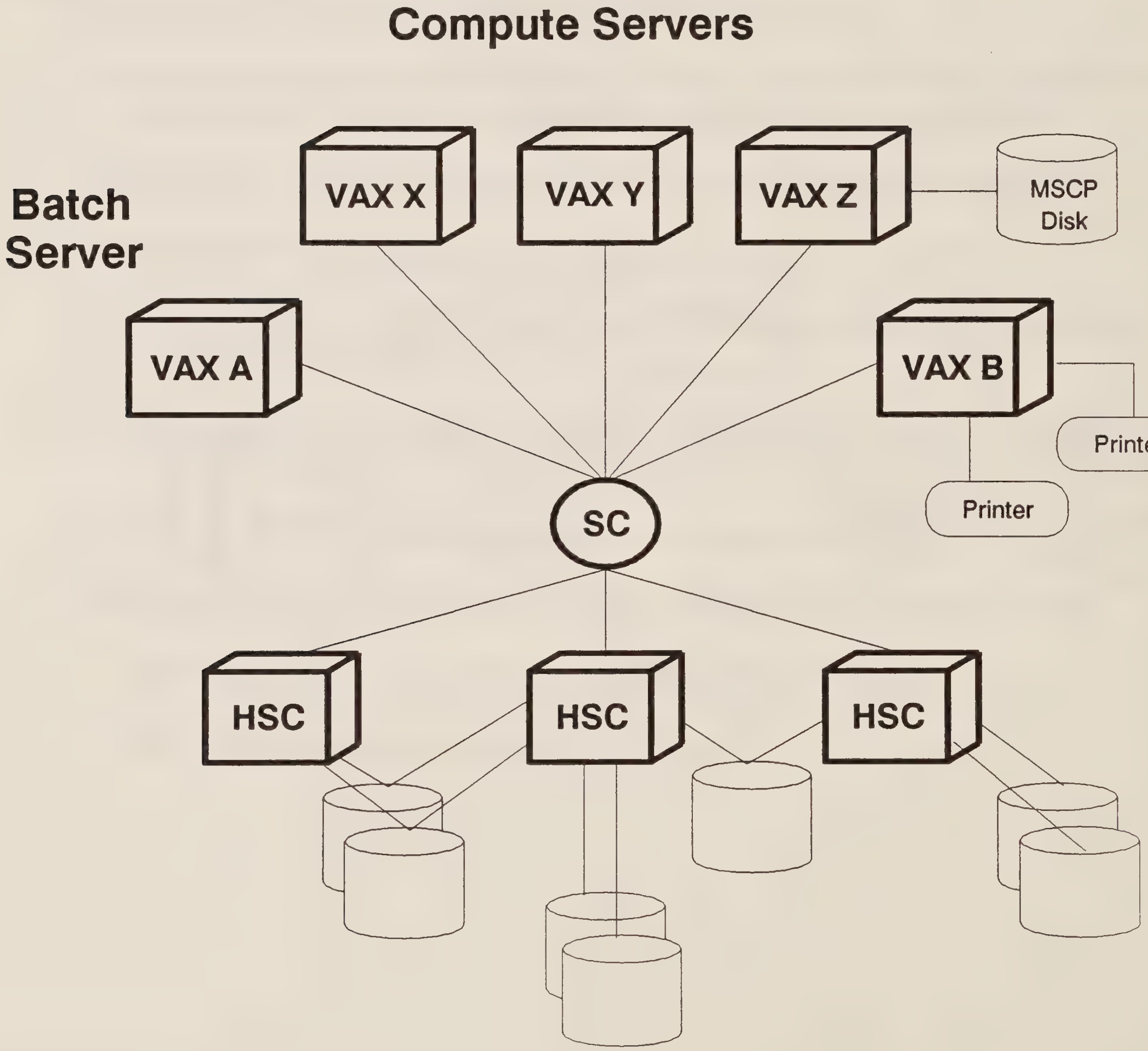
NI and CI Comparison

- The primary differences between the NI and CI are:
    - > The NI is significantly slower. The SCS protocols may also have to compete for cable time with other unrelated network traffic.
    - > The NI is not fault tolerant. Dual data paths are not available.
    - > HSCs are not used in a LAVC.
    - > The CI requires a computer room and associated environmental controls. The NI does not.
    - > The operational radius of an NI is much larger. The CI has a maximum radius of 90m. The NI could be up to 1,500m.
    - > The NI normally connects MicroVAX size processors.
    - > MicroVAXes can not directly participate in a CI environment.
    - > The CI is more expensive by several magnitudes.
    - > The NI allows more nodes.

CI Configuration I



CI Configuration II



Compute Servers

Batch Server

VAX X

VAX Y

VAX Z

MSCP Disk

VAX A

VAX B

Printer

Printer

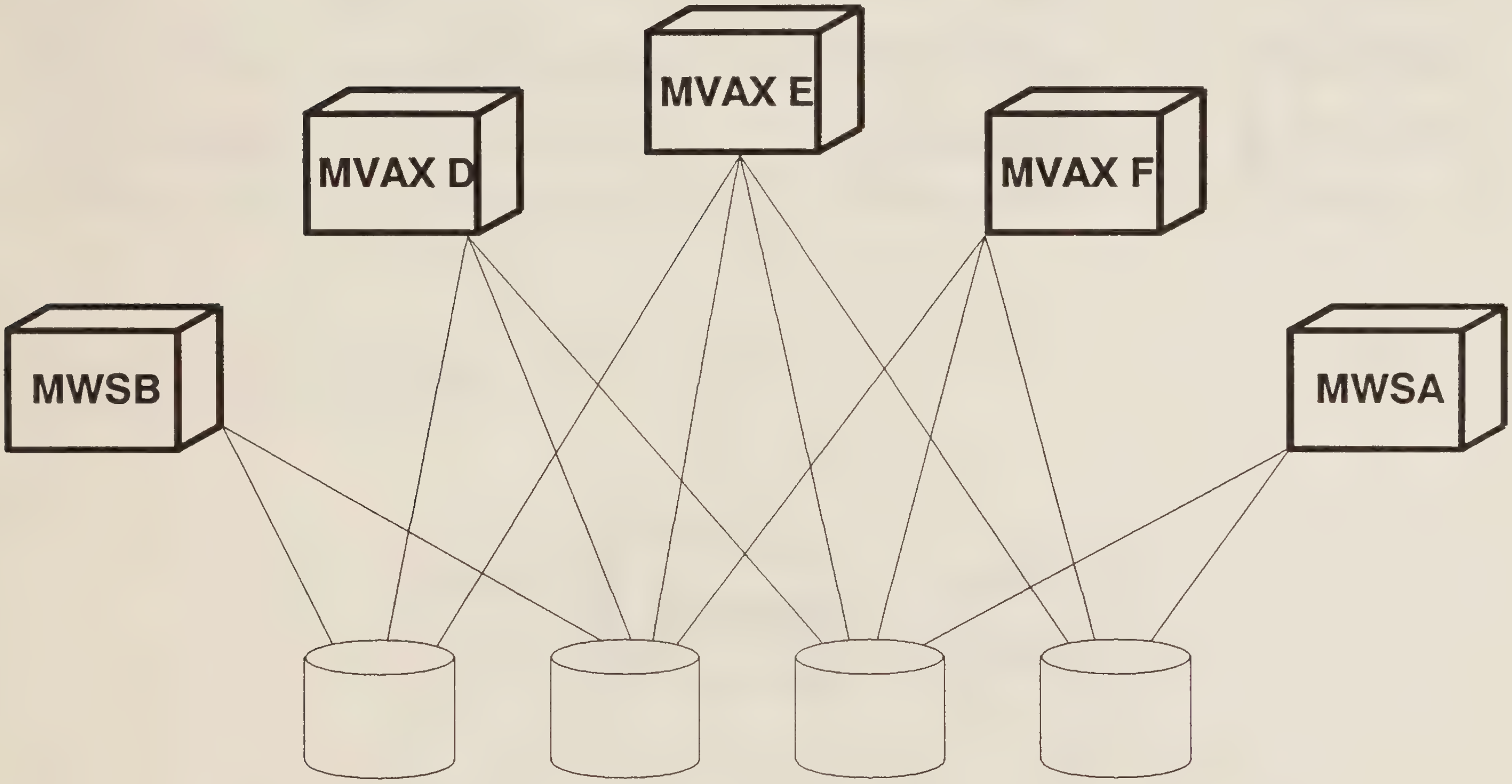
SC

HSC

HSC

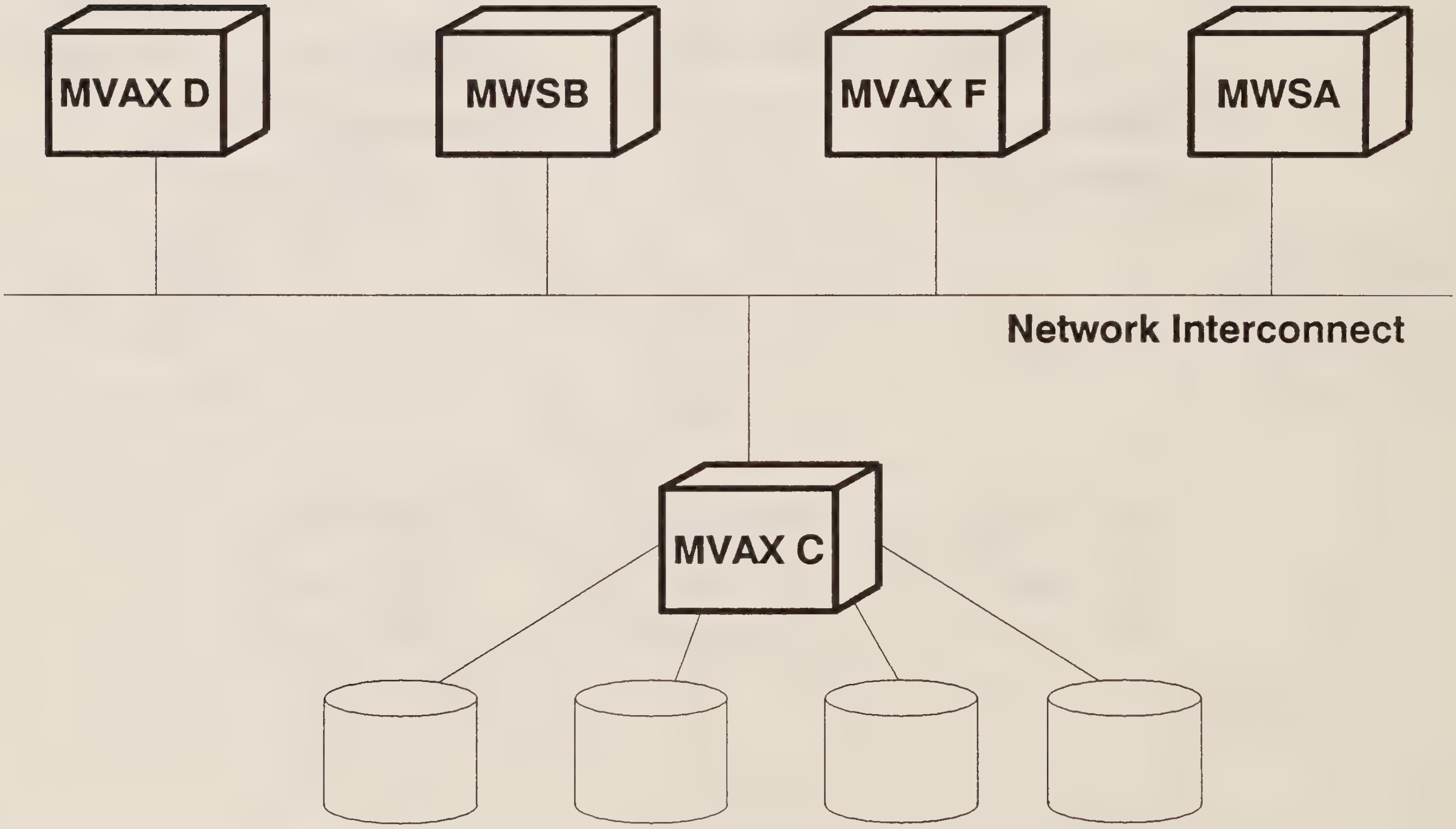
HSC

LAVC Logical Configuration

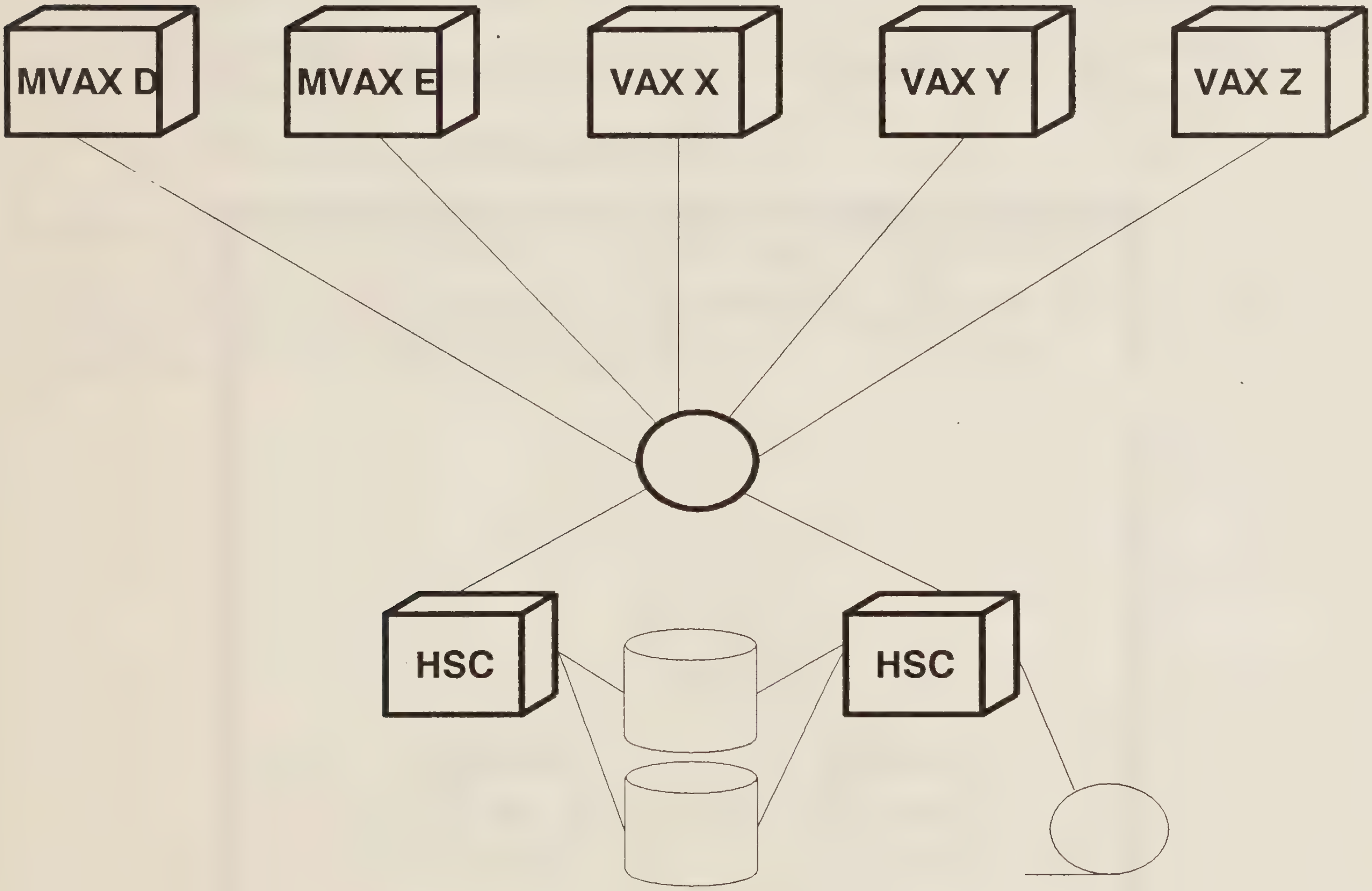


LAVC Physical Configuration

- **Maximum of 26 nodes in a LAVC configuration.**

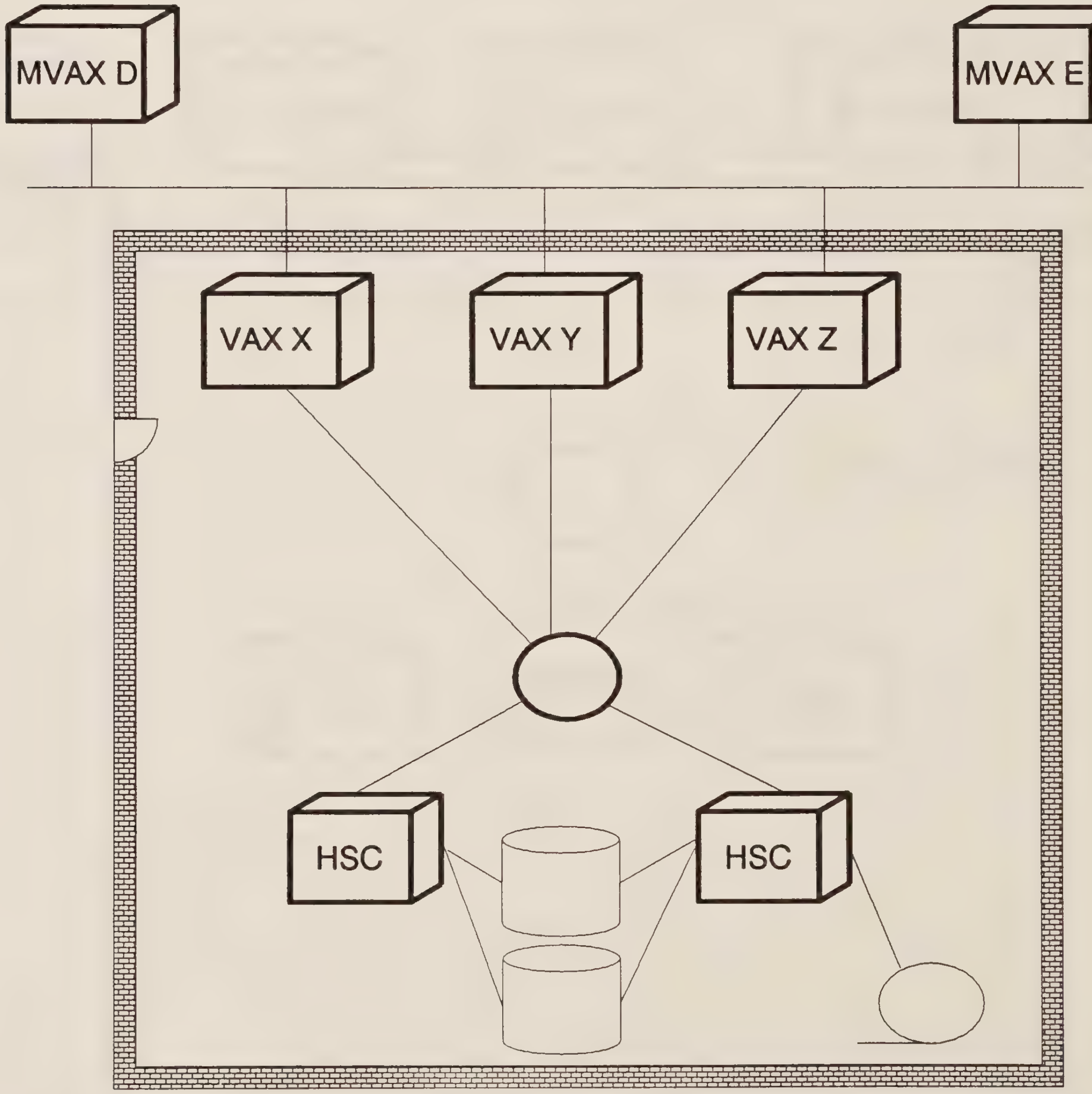


LAVC Hybrid Logical Configuration



LAVC Hybrid Physical Configuration

- **A maximum of 42 nodes in a hybrid configuration.**



LAVc Implications

- All swapping and file activity on a diskless node is done over the Ethernet. This means that you will increase the amount of traffic and may increase the number of potential collisions. You may wish to investigate:
    > A Work Area Network scenario to isolate traffic.

    > Local Paging and Swapping disks.
- Memory is a key ingredient on any form of LAVc client system.
- Many SCS functions are implemented in software rather than in the CI controller as they are in a cluster.

Fault Lenient Systems

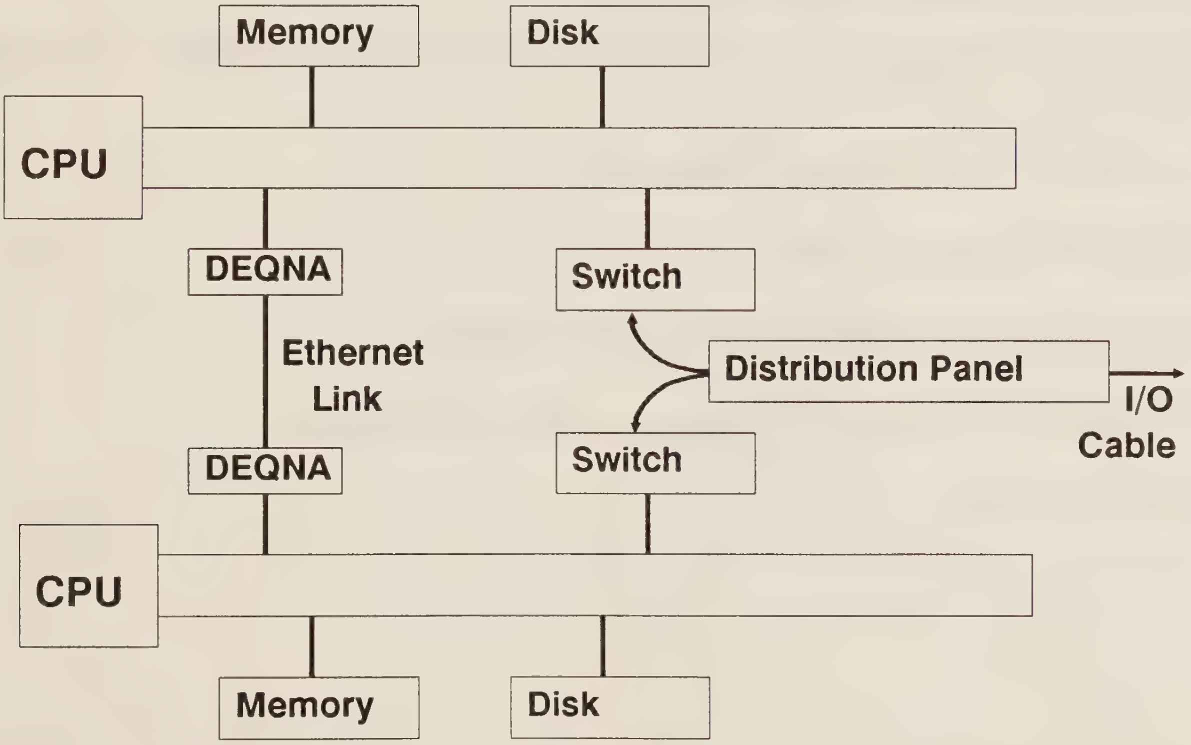
- DEC systems are not fault-tolerant in the sense of a Tandem processor but can be configured to maximize availability.
- Dual path disks provide redundancy in case of a HSC failure. Volume shadowing can protect against disk failures. Both techniques can also increase performance for retrievals.

MIRA

- Microcomputer Implementation of a Reliable Architecture (MIRA) is designed to eliminate the single point of failure in critical designs.

- Consists of two fully duplicate MicroVAX or MicroPDP computers in a single cabinet. Has a switch that detects CPU failure and automatically switches synchronous and asynchronous lines to a good CPU.

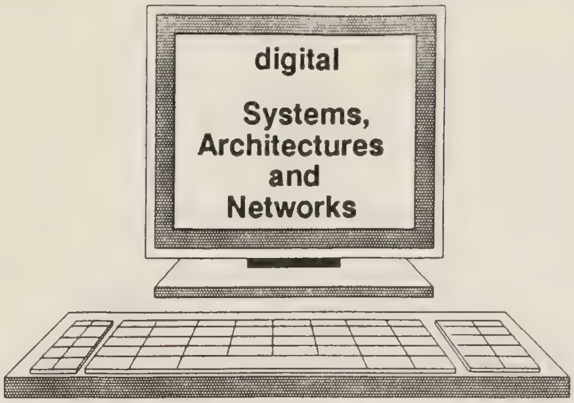
- Based on the MicroVAX II, MicroVAX 3500/3600 or MicroPDP 11/83 series computers. Can be used in hot or cold stand-by mode.



High Availability

- Techniques to Achieve High Availability
    - > Over Design
    - > On-Site Spares
    - > Redundancy
    - > Failure Prediction
- Considerations
    - > Eliminate Single Point of Failure
    - > Be Able To Detect a Failure
    - > Be Able To Continue Processing
    - > Minimize Loss of Data
    - > Repair, Verify, Put On-Line Failed System
    - > Phase-In HW and SW Changes Without Breaks
- BE AFFORDABLE

VAXCLUSTERS



Key Concepts in This Section

- There are three kinds of clusters: LAVc, CI bus, and Hybrid cluster.
- All three kinds implement the Systems Communications Architecture.
- HSC Controllers, dual-ported disks and volume shadowing are tools that make CI bus clusters a high availability configuration. Another advantage is scalability for upgrades.
- LAVc and Hybrids are typically used for VAXstations used in CAD/CAM, publishing or other graphics intensive applications.
- Fault Lenient Systems and High Availability can be achieved, at a price.

VAXcluster Exercise

- Your Specialty Investments subsidiary markets socially responsible investment portfolios to targeted groups. Their director attended a DEC Systems and Architectures seminar and didn't quite grasp all the details. He did, however, decide to notify the BLUE LEASING COMPANY that their IBM 4381 would have to be removed in 5 months.

- As per your request, the various department have submitted the following requirements:

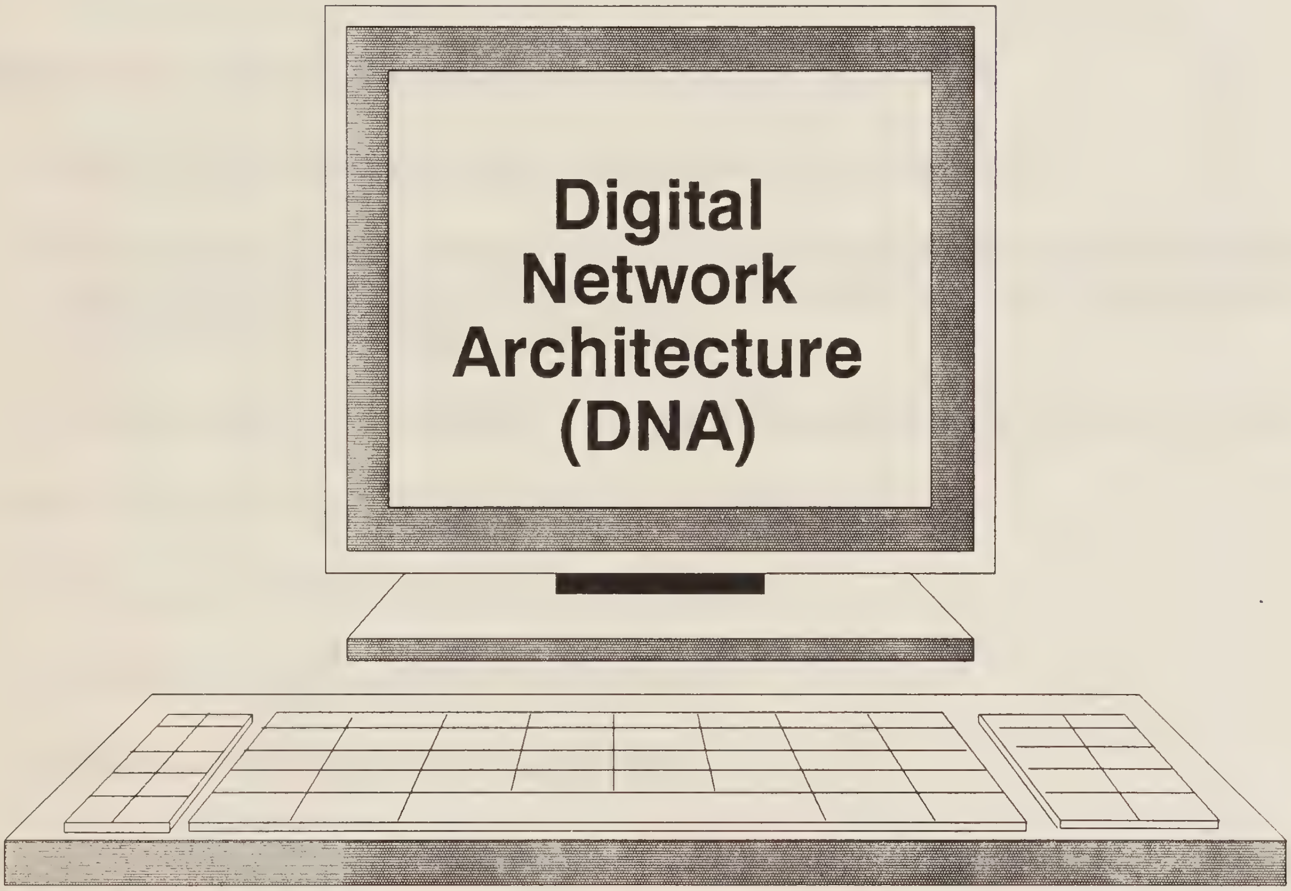
Department	DISK	Functions
Accounting	500 MBytes	Transactions
Finance	1 GByte	DB Access and Analysis
Customer Service	500 MBytes	Inquiry
Mailing Services	1 GByte	Nightly Processing

- In response to your question about interconnection of nodes, the director explained that a corporate Ethernet will be installed. A little inquiry on your part has uncovered a 2 GByte database, 400 MBytes of user files and 100 MBytes of system and software files.

- On the next page, sketch a first cut draft of how you would meet the user requirements. Make sure to consider how many nodes, which nodes could be clustered, which ones shouldn't be, node access, local v. HSC drives, volume shadowing and dual ported systems.

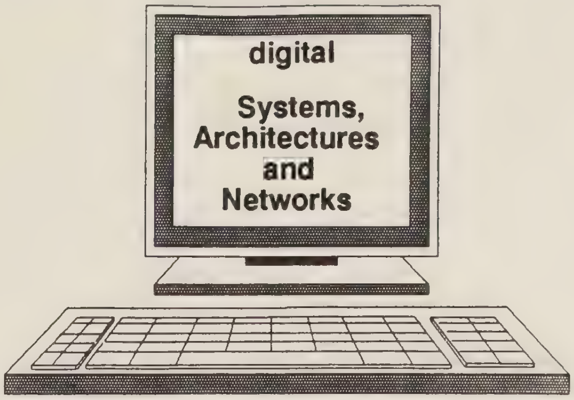
Your Cluster Configuration:

> **"Economists exert a minor and scarcely detectable influence on the societies in which they live."**
>
> *George Stigler, Nobel Prize winning economist*



Digital Network Architecture (DNA)

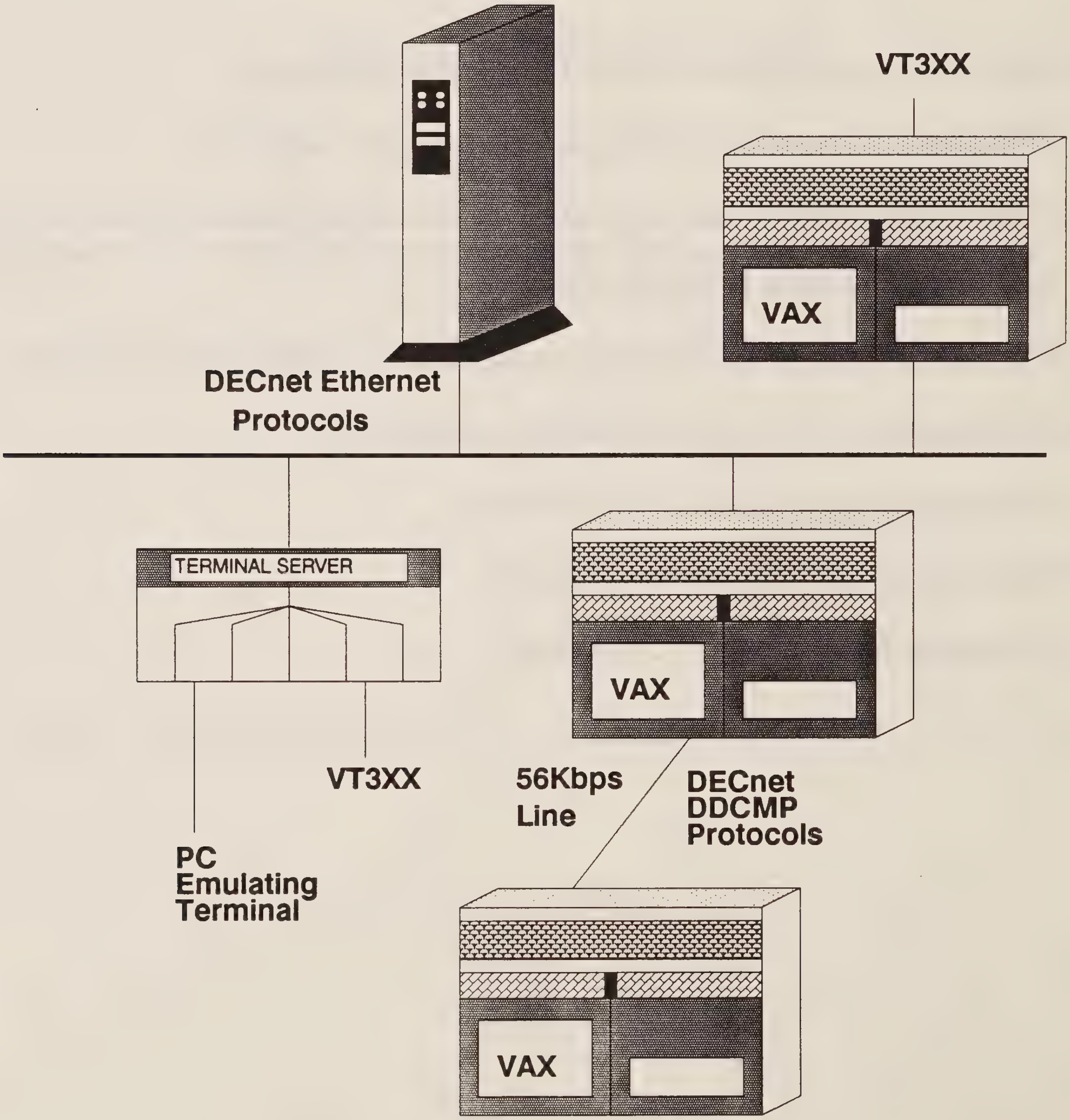
DIGITAL NETWORK ARCHITECTURE



Overview

- DECnet can include three different data link protocols.
    - > Ethernet is used for high-speed local area networks.
    - > The Digital Data Communications Message Protocol (DDCMP) is used for older (Phase III) DECnet and point-to-point connections such as leased telephone lines.
    - > An alternative to DDCMP for point-to-point connections is X.25.
- Several network services are available including
    - > Access to Data Across the Network
    - > Remote Login Across the Network
    - > Network Management Capability

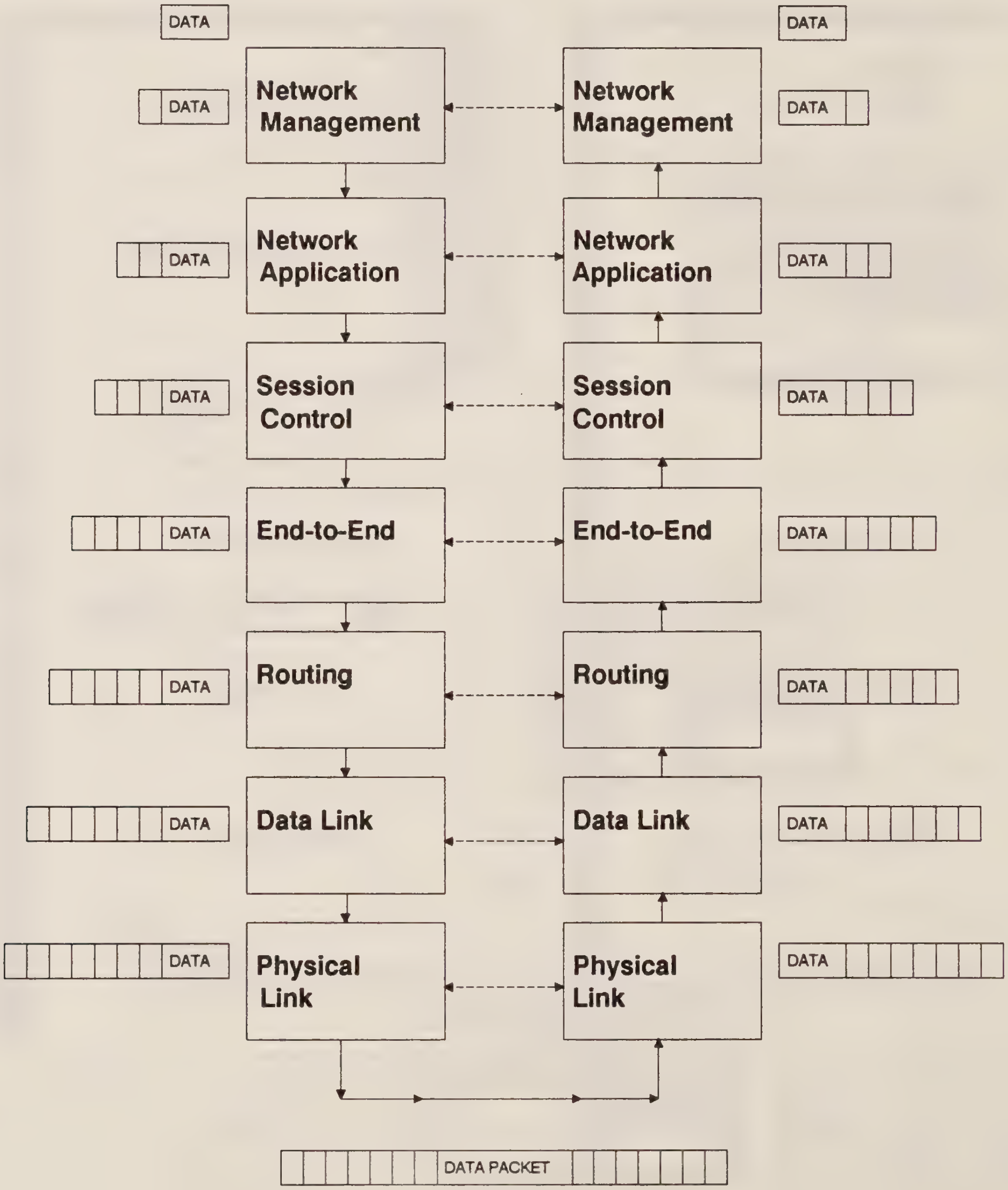
A DECnet Distributed Network



DNA v. ISO

ISO	DNA
Application	User/Net. Mgmt.
Presentation	Network Application
Session	Session Control
Transport	End-to-End
Network	Routing
Data Link	Data Link
Physical Link	Physical Link

Peer to Peer Protocols

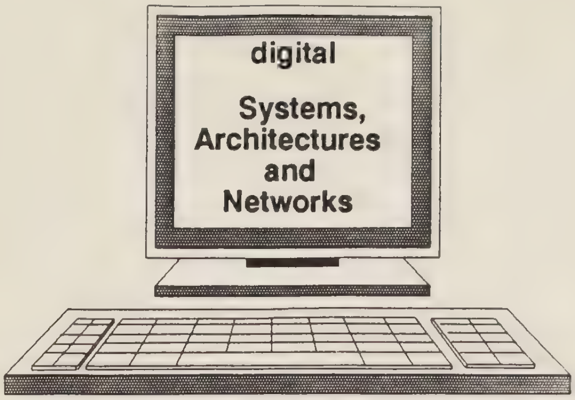


DNA Phase I

- RSX-11M; PDP-11S
- Program to program communication
- File transfer
- 1976-77

DNA Phase II

- All operating systems
- Remote file access
- File transfer between dissimilar systems
- Primitive network management
- Point to point configurations
- User interface
- 1977-78

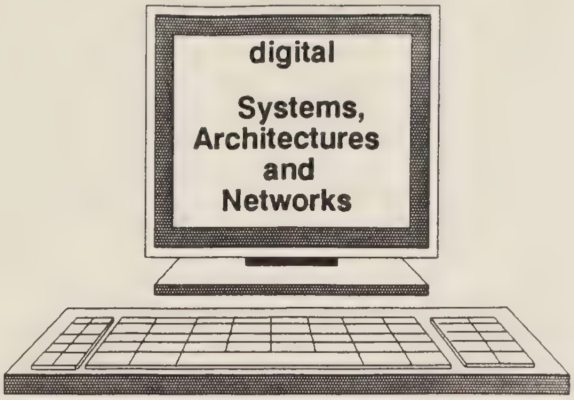


DNA Phase III

- Adaptive routing and concept of routing
- Multi-point configurations
- Network sizes up to 255 nodes
- Distributed network management
- CCITT X.25 support
- Record access
- Down-line loading
- 1980-81

DNA Phase IV

- Ethernet support
- Concept of network "areas"
- Communications servers
- Routers, bridges, gateways
- SNA Servers
- DECConnect cabling system
- X.25-based networks
- 1982-?? (92)



DNA Characteristics

- User is isolated from details of network topology.
- User is isolated from details of network configuration.
- Functions implemented at highest possible level.
- Circuit-oriented interface: requires commands and messages for path connection, data transfer and path disconnection.
- High data integrity. Bit and block error detection and correction with sequencing, missing block detection and bits in error.
- Reliability. Adaptive routing for both node and channel failures. Correction for out-of-sequence and missing messages through end-to-end control.
- No central point of failure. Functions distributed throughout the network.
- Bursty traffic. Channels are dynamically shared. Sharing has overhead but provides better channel use. Note that this may not be appropriate in applications (i.e. factory automation) requiring constant availability.

Layer 1: Physical

- Transfer a stream of bits over various communication media include twisted wire, coax, microwave, optical fiber, etc. ...

- RS-232C and Ethernet COAX cables or CATV Broadband systems are examples of physical media.

- Physical channels can be shared among users using techniques such as Frequency Division Multiplexing, Time Division Multiplexing, Concentration.

- The physical media that can be used depends on the availability of a data link protocol.

- In Ethernet, carrier-sensing and collision-detection is done by the transceiver at level 1.

Layer 2: Data Link Layer

- **The Data Link Layer frames message packets into bits for passage to the physical layer. It takes bits from the physical layer and forms them into message packets.**
- **DNA Supports 3 Different Data Link Layer Protocols**

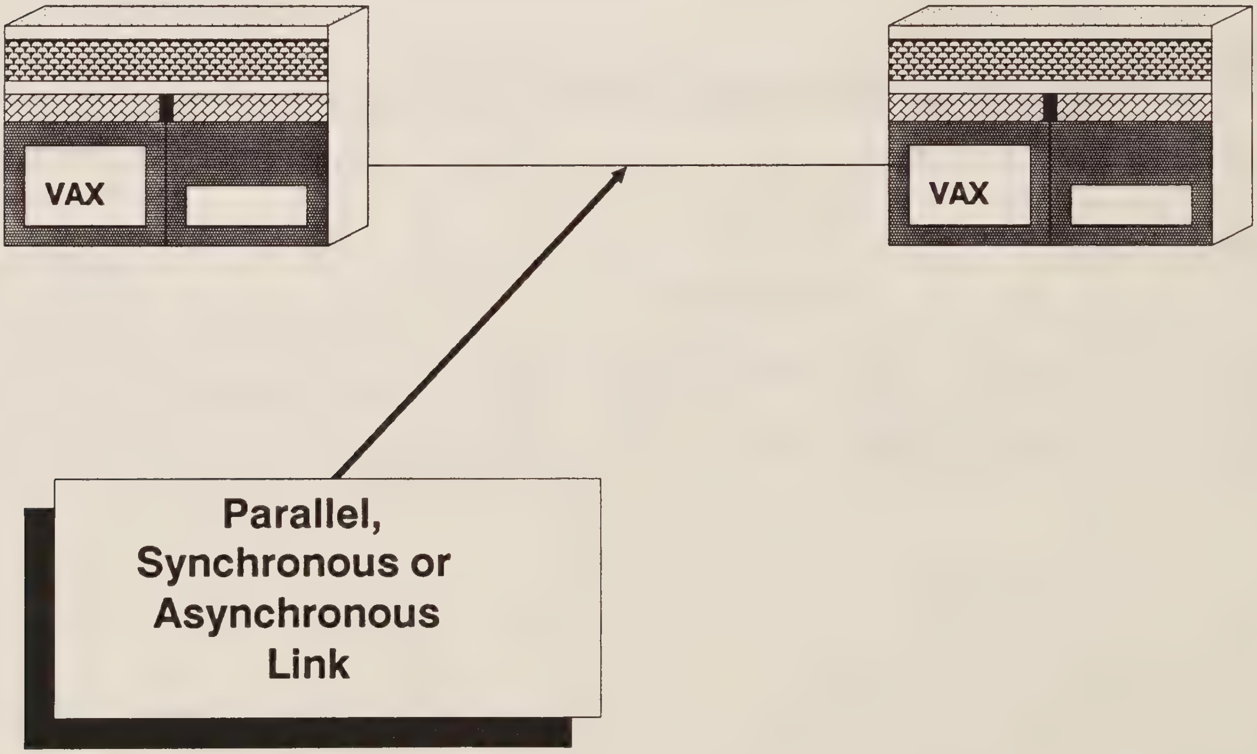
<table>
<tr><td>Routing</td><td colspan="9"></td></tr>
<tr><td rowspan="2">Data Link</td><td colspan="5">802.2 LLC</td><td colspan="2" rowspan="2">DDCMP</td><td colspan="2">CCITT X.25
Packet Layer</td></tr>
<tr><td colspan="5">802.3 Ethernet</td><td colspan="2">LAPB/LAPBE
HDLC Framing</td></tr>
<tr><td>Physical</td><td>Thickwire
Baseband
10Mbs</td><td>Thinwire
Baseband
10Mbs</td><td>Broadband
10Mbs</td><td>Unshielded
Twisted
Pair
10Mbs</td><td>Fiber
Optic
10Mbs</td><td>Asynch</td><td>Synch</td><td>V.35</td><td>RS-232C</td></tr>
</table>

[LAYER2]

Layer 2: DDCMP

- Digital Data Communications Message Protocol (DDCMP) provides data link control. Operates on various channel types: synchronous, asynchronous, parallel. Uses positive acknowledgement and retransmissions for recovery. The data link layer controls the physical link.

- Framing takes data from a stream-oriented physical channel and turns it into block oriented messages for use by the higher layers. The framing technique uses a count framing technique. The header contains the number of bits transmitted.

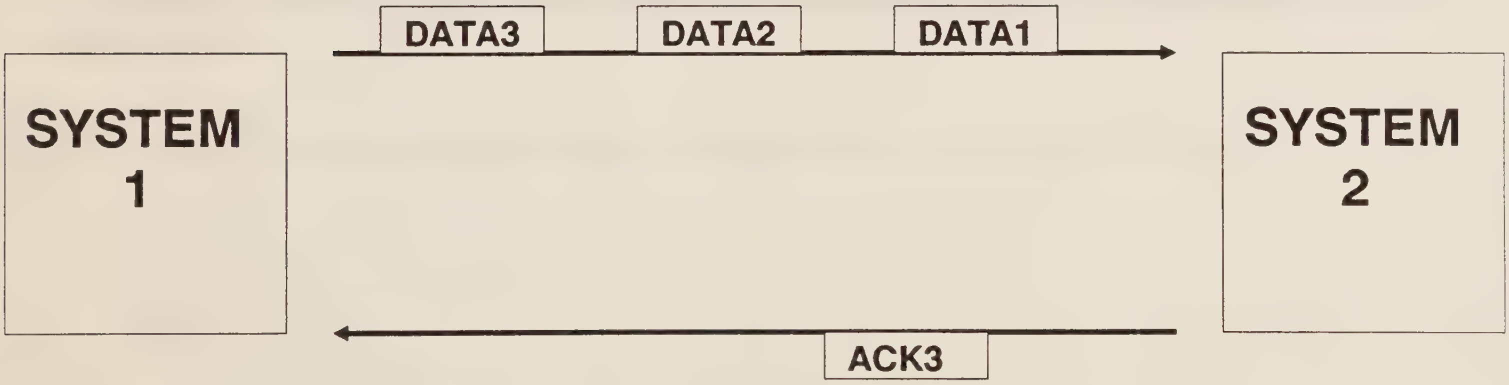


DDCMP PAR Technique

- Once a block is sent, there has to be a method for making sure we can go on to the next block. DDCMP uses a Positive Acknowledgement Retransmit (PAR) technique.

- When a message is received properly, an ACK is sent over the line. If an error was detected, a NAK asks for retransmissions. If the sending node does not receive any acknowledgement, it assumes a NAK and retransmits.

- Because multiple blocks can be in the pipeline due to delays, ACKs and NAKs have a sequence number associated with them. Not all messages must be acknowledged. An ACK for a higher sequence number assumes acknowledgement of previous messages.



Ethernet

- Operates at layers 1-2. Alternative to DDCMP.
- Ethernet uses the Carrier-Sense Multiple-Access/Collision-Detection (CSMA/CD) technique. If a collision is detected, nodes wait a random amount of time before trying retransmissions.
- Best-effort delivery at layers 1-2. Error detection in DNA provided by the End Communication layer, using the Network Service Protocol (NSP).
- Data encapsulation frames data, puts on a source and destination address and adds on a Frame Check Sequence for detection of transmission errors at the physical level.
- Link management handles channel allocation (collision avoidance) and contention resolution (collision handling). The Transmit Link Management detects repeated collisions, increases the random retransmission time, and thus tries to delay collisions.

Ethernet Frames

- Independent of the higher level protocol.

Destination	Source	Type	Data + Pad	Check Sum
48	48	16	46-1500	32

- DESTINATION: Physical addresses are a unique address for a node. Consists of a 32 bit DNA prefix and a 16 bit station address. Multicast addresses allow addressing all End nodes or all Routers. The Broadcast address is used for all addresses on a single Ethernet.

- TYPE: The type of protocol (i.e. DECnet) in the frame. This is why multiple network architectures can share a single Ethernet.

- DATA: 46 to 1500 bytes long. Minimum length is necessary to insure that all frames occupy the channel long enough for reliable collision detection.

- PAD: zero or more bytes, depending on the actual data length.

802.3 Frame

Destination	Source	Length	Data + Pad	Check Sum
48	48	16	46-1500	32

- **DESTINATION: 46 bit global address**
  - **> 2 bit local address**
- **SOURCE: 46 bit global address**
  - **> 2 bit local address**
- **CHECKSUM: 32 bit hash code of data.**

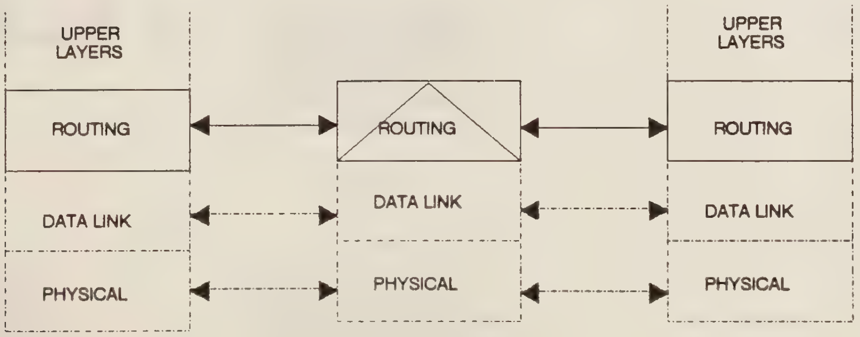
Layer 3: Routing

- Selects routes based on network topology and operator-assigned circuit costs. Can adapt to changes in the network topology. Note that the amount of traffic on a circuit does not affect path selection.

- Routing uses a datagram service which delivers packets on a best-effort basis. Guarantees against lost packets, duplication or out-of-order delivery are handled by the next layer (End Communication).

- DNA has Routing and Non-routing (End) nodes in Phase IV. Congestion control manages buffers by limiting the maximum number of packets on a queue for a circuit. Transmit management discards packets over a pre-determined threshold for that queue. Transmit management also regulates the ratio of packets received locally from the End Communication layer to route-through packets to prevent degradation of route-through services.

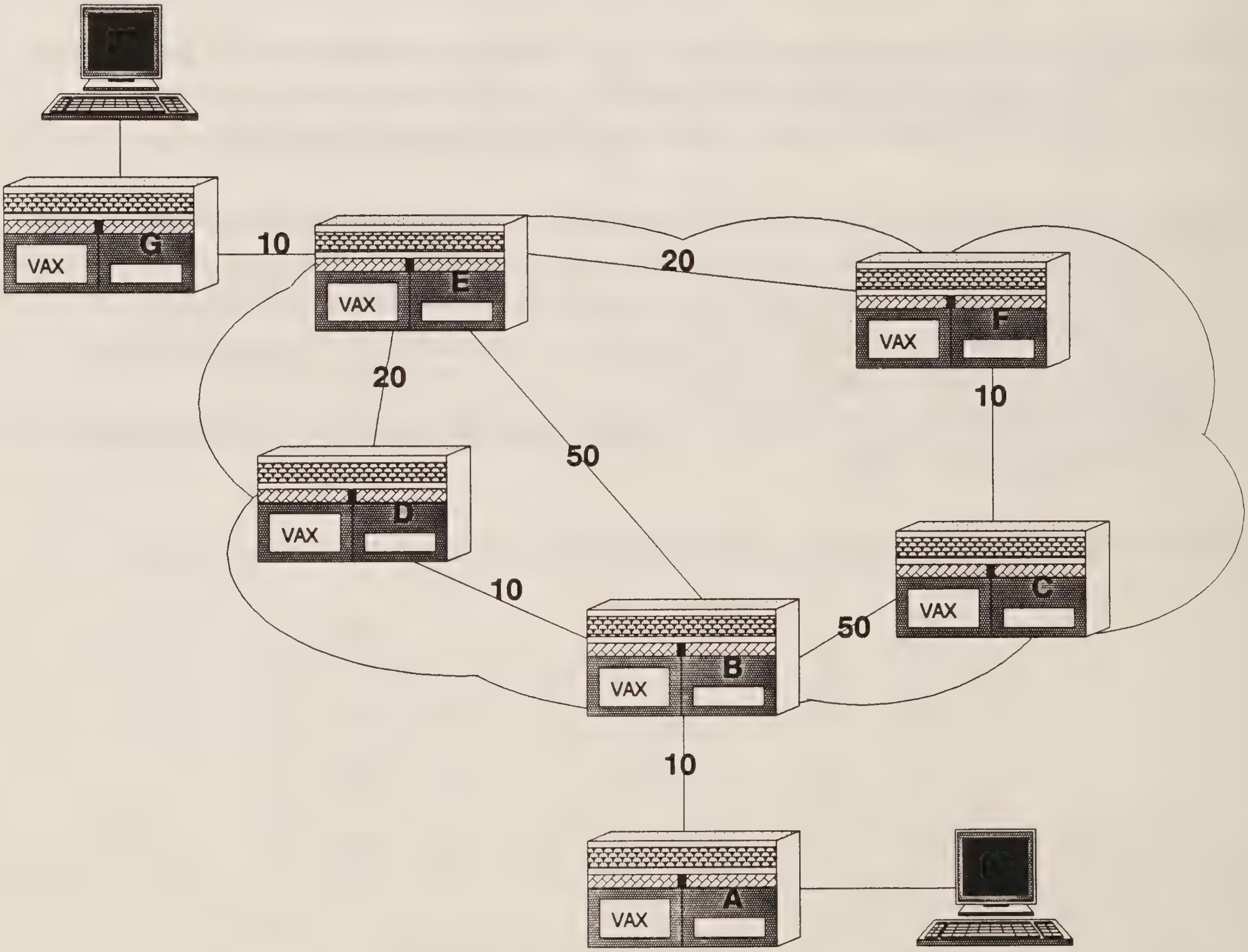
- Lifetime control discards packets that have visited too many nodes.

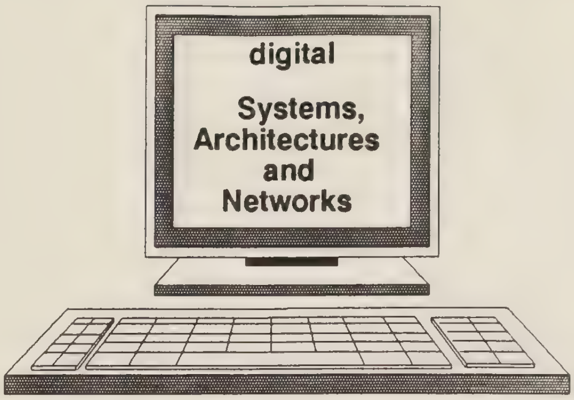


[LAYER3]

Routing Decisions

- Routing decisions are made by determining the line costs and the number of HOPS between the local and remote nodes. The network manager assigns line costs using circuit bandwidth as the determinant.





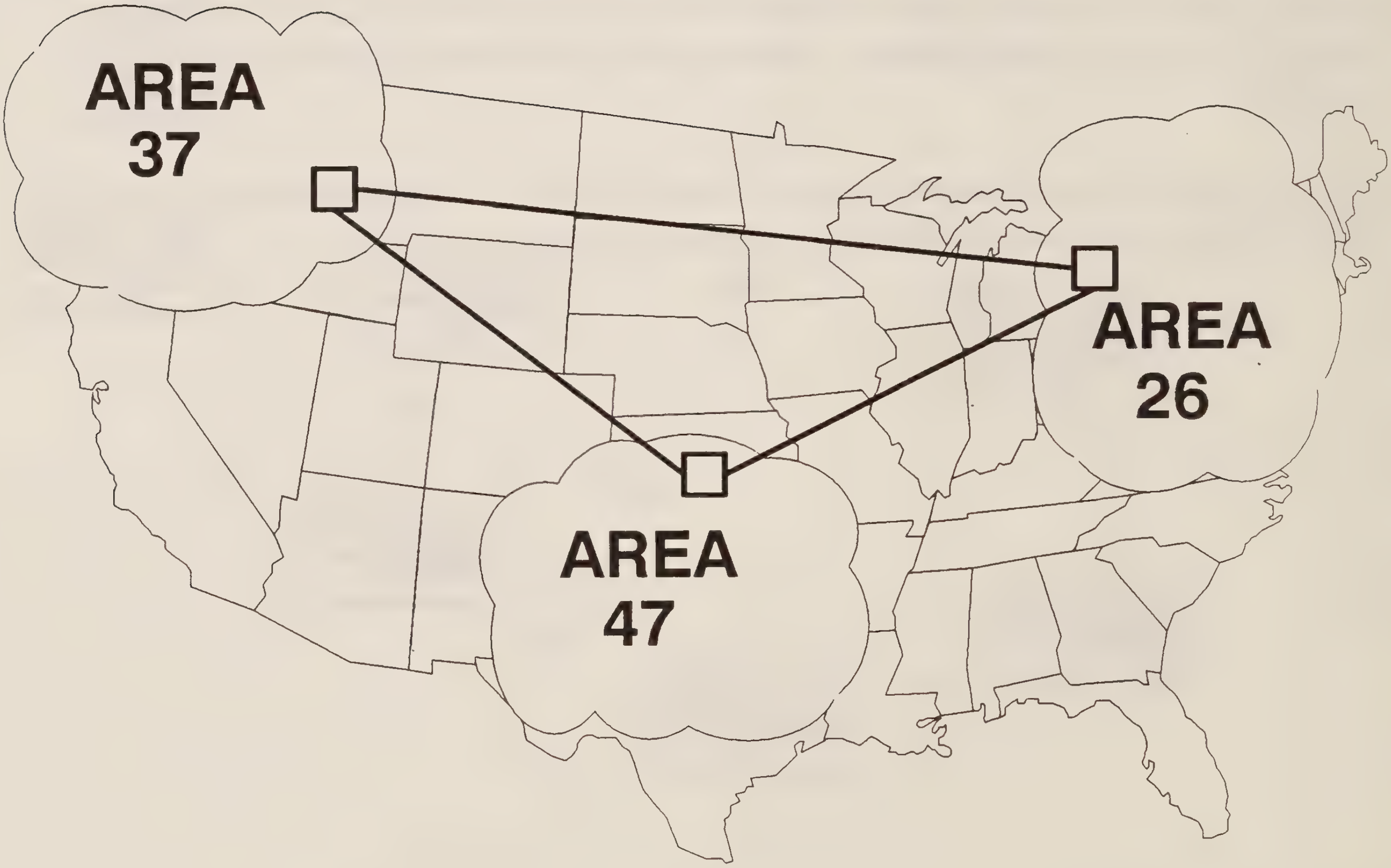
Areas and Routers

- DECnet has a two layer routing scheme. Up to 1023 nodes may be in an area. Up to 63 areas may be in a DECnet.

- Every area in a multi-area DECnet has a designated Level 2 Router that keeps track of other areas in the network. The level 2 routing scheme is static.

- System manager can set the maximum number of hops allowed. The Routing architecture limits this number to 63.

Level 2 Routing

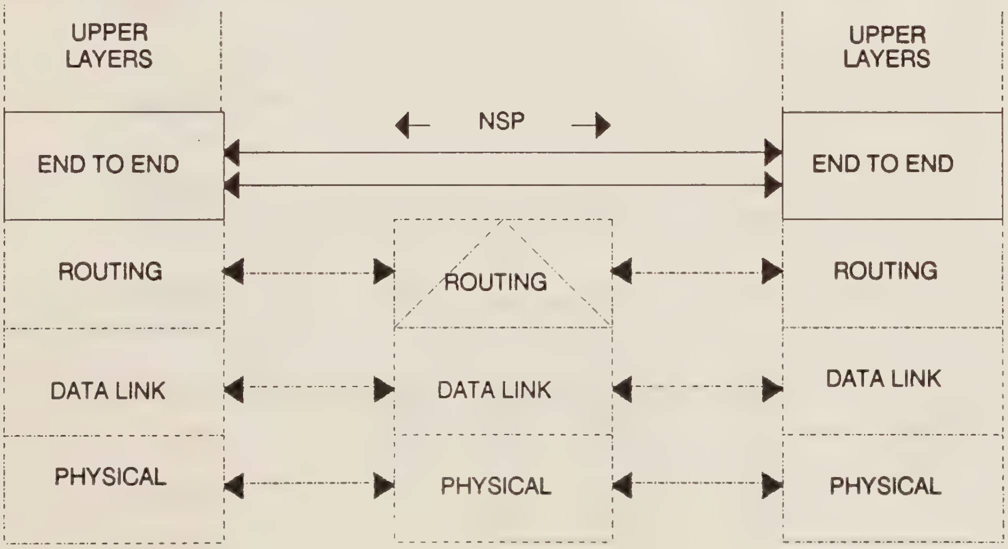


Layer 4: End Communication Layer

- Uses the Network Services Protocol (NSP) to create and destroy logical links, guarantee the delivery of data and control messages in sequence and without errors. NSP is responsible for assembling and disassembling higher level data messages into segments for passage to the routing layer.

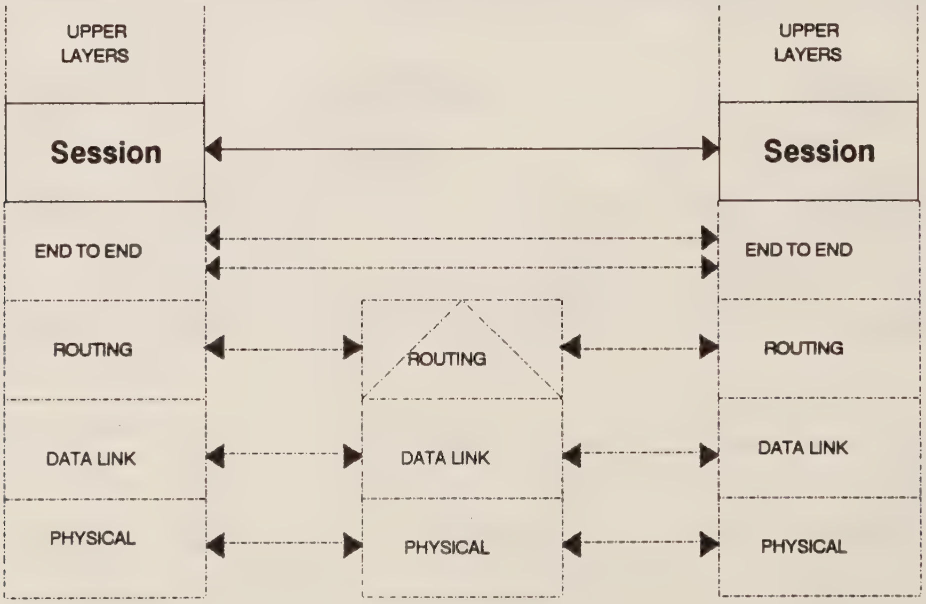
- Within a logical link (also called a Virtual Circuit) there are two logical data sub-channels. The Normal Data Sub-channel carries data messages between two NSP modules. The Other Data Sub-channel carries interrupt messages, data request messages and interrupt request messages.

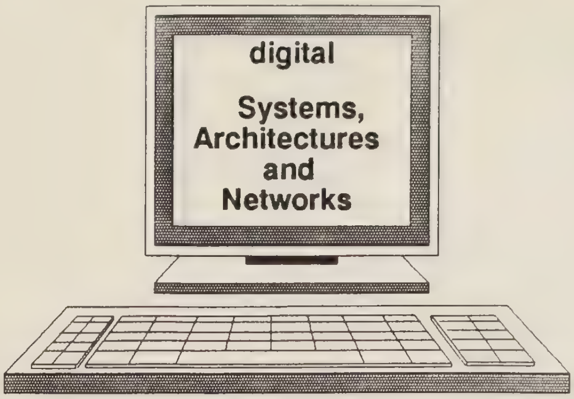
- Each datagram is broken up into segments and numbered. If data is not received, or received too far out of order, a NAK is sent by the receiving NSP. If an ACK is not received or a NAK is received, the sending NSP retransmits.



Layer 5: Session Control Layer

- Provides system-dependent, process to process communications functions.
- Maps node names (i.e. VAXA::filename) into node addresses (43.102) for passage to the End Communication layer.
- Activates process to handle incoming connect requests. Validation functions access system dependent control information on incoming requests.
- The Session Control layer uses two databases. One maps node-names, the other contains the states of Session Control and optional default connection timers.





Layer 6: Network Application Layer

- Now contains five independent services specified by Digital.
  - > Data Access Protocol. Permits remote file access and file transfer independent of the I/O structure of the remote operating system.
  - > Network Virtual Terminal Protocols. Permits terminals connected to a local host DECnet system to access remote host systems.
  - > X.25 Gateway Access Protocol. Allows user-written modules total access to non-DECnet systems across an X.25 network.
  - > SNA Gateway Access Protocol. Allows user-written modules and several DEC modules (that is, DISOSS access) to communicate with application programs in a SNA network.
  - > Distributed System Services. A new family of services that form a bridge to DNA Phase V.

Data Access Protocol

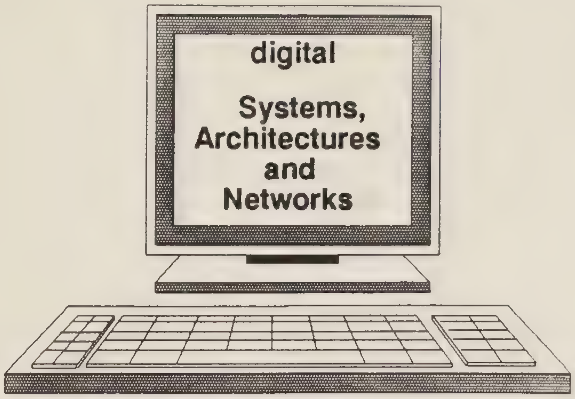
- File Access Listener (FAL). Receives I/O requests from remote processes and acts on the user's behalf. DNA General Description calls this a remote DAP-speaking server process.

- Record Management Services (RMS). Hides details of disk I/O from user. Allows systems, such as DECnet-VAX, transparent access to other DECnet nodes. File requests that include node names are mapped by RMS into DAP messages. The DAP messages are then sent to a remote FAL listener.

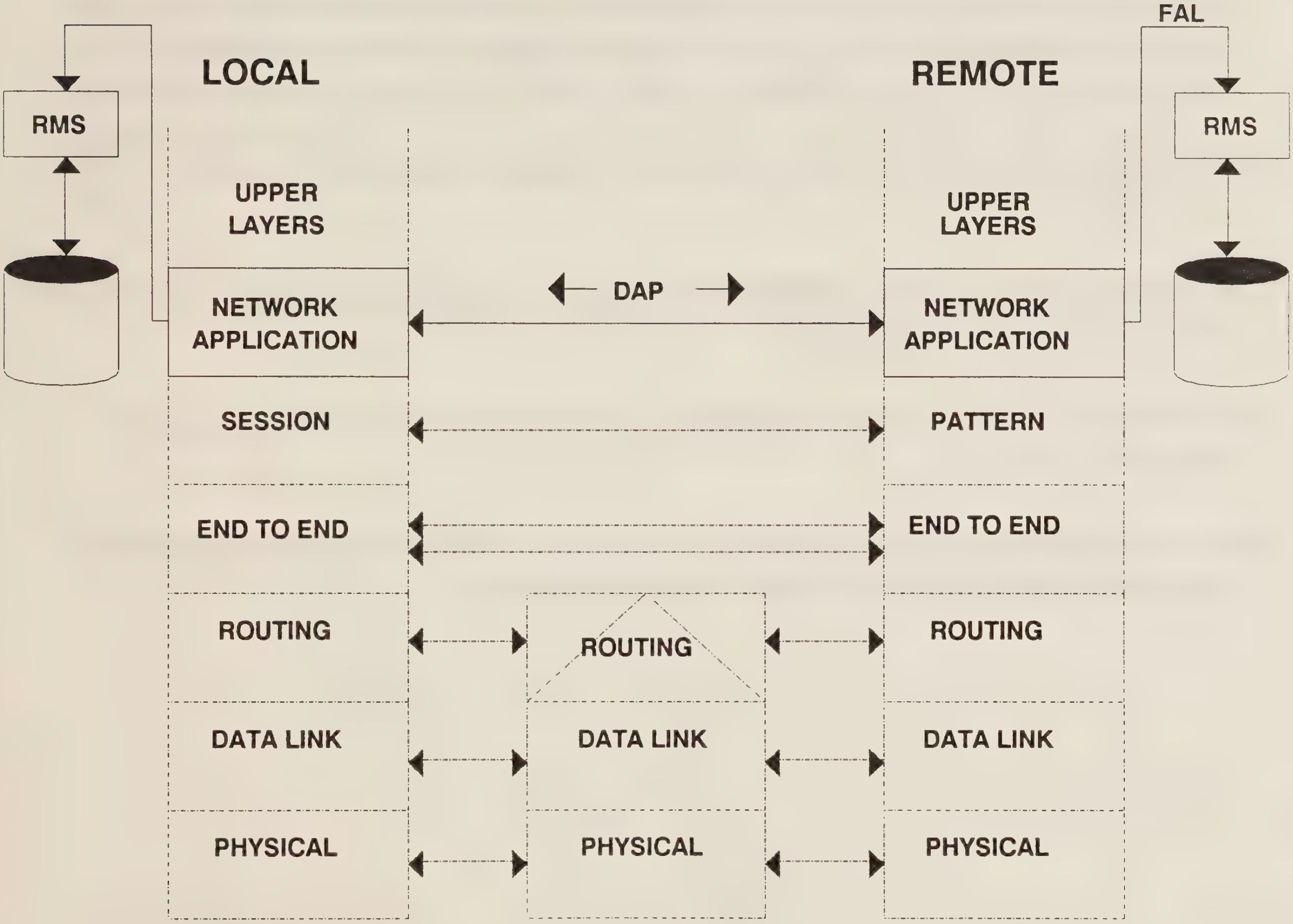
- Configuration messages are sent after NSP logical link set up. Includes information on operation system, file system, protocol version, buffering capabilities.

- Attribute messages include information on how specific data is to be accessed including file organization, data type, format, record attributes, record length, size, and device characteristics.

- Other DAP messages include access information on file name and type of access requested, and control and status messages to set up data streams. DAP provides for error recovery and file information such as key definitions for indexed files, allocation characteristics when explicitly extending files, time-related information about files, or file protection codes.



DECnet DAP Services



LOCAL

RMS

UPPER LAYERS

NETWORK APPLICATION

SESSION

END TO END

ROUTING

DATA LINK

PHYSICAL

DAP

ROUTING

DATA LINK

PHYSICAL

REMOTE

FAL

RMS

UPPER LAYERS

NETWORK APPLICATION

PATTERN

END TO END

ROUTING

DATA LINK

PHYSICAL

DECnet System Services

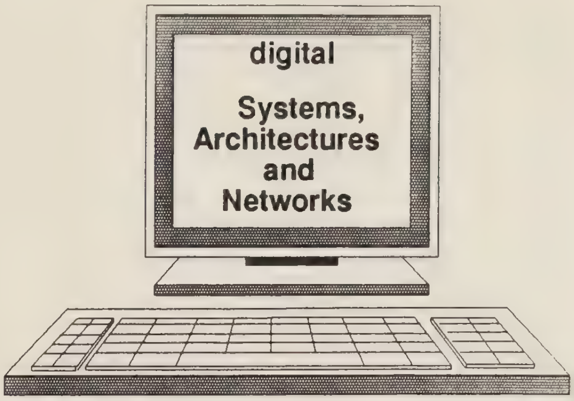
- The DSS family of products address the problems associated with a distributed computing environment. DSS makes a network of VAX computers appear to be a single system. Network resources can be managed and used as if they were directly attached to the local node.

- Distributed Naming Service (DNS). Provides a method of naming network resources.

- Distributed File Service (DFS). Provides for network-wide file management and operation.

- Distributed Queuing Service (DQS). Provides for distributed usage of network printers.

- Remote System Manager (RSM). Provides a method to manage multiple remote systems as if they were a single system.



Distributed Naming Service

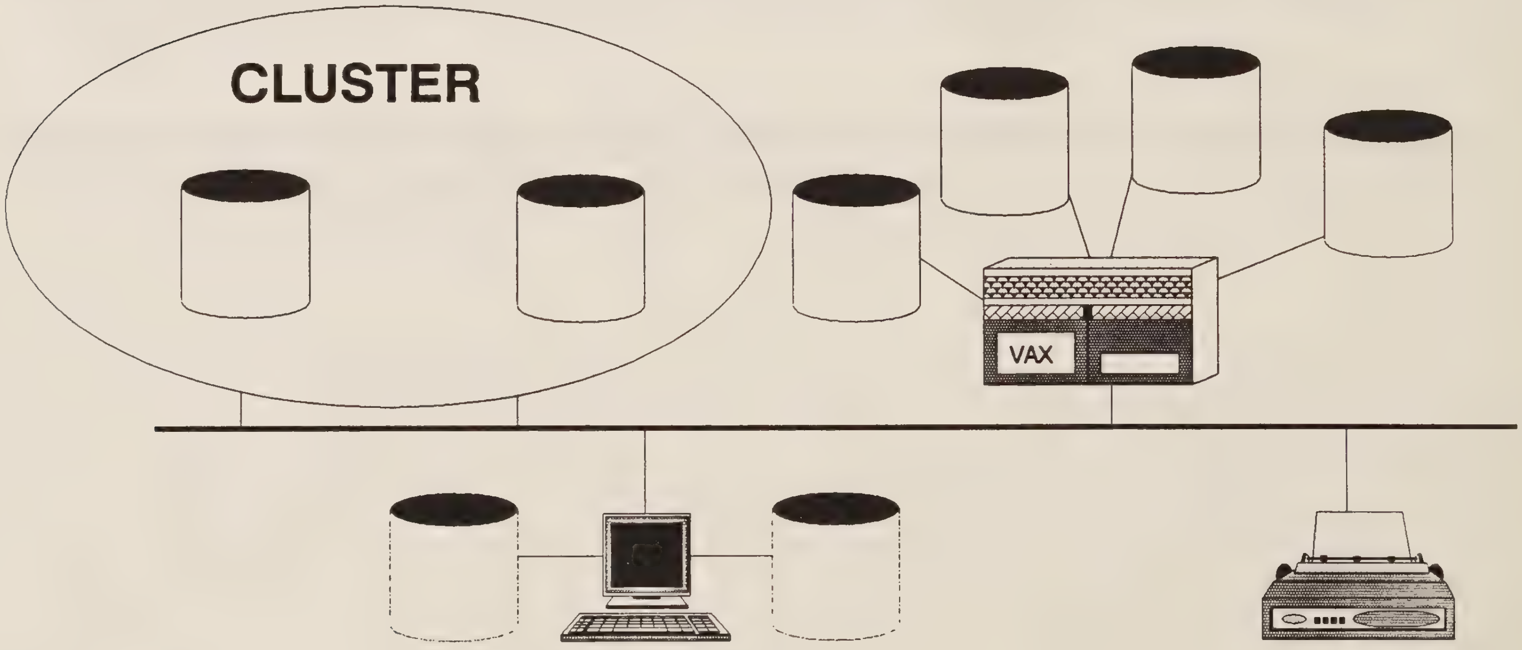
- The Distributed Name Service provides a means to globally identify objects (files, printer, nodes, etc). Users can refer to network resources without having to know where the resource is located. Uses the client/server configuration. This is the foundation layer for the other three services. DNA information is stored in databases. If two or more DNS nodes are present, the DNS nodes will automatically update each other.

- DNS names must be unique across the network.

Distributed File Service

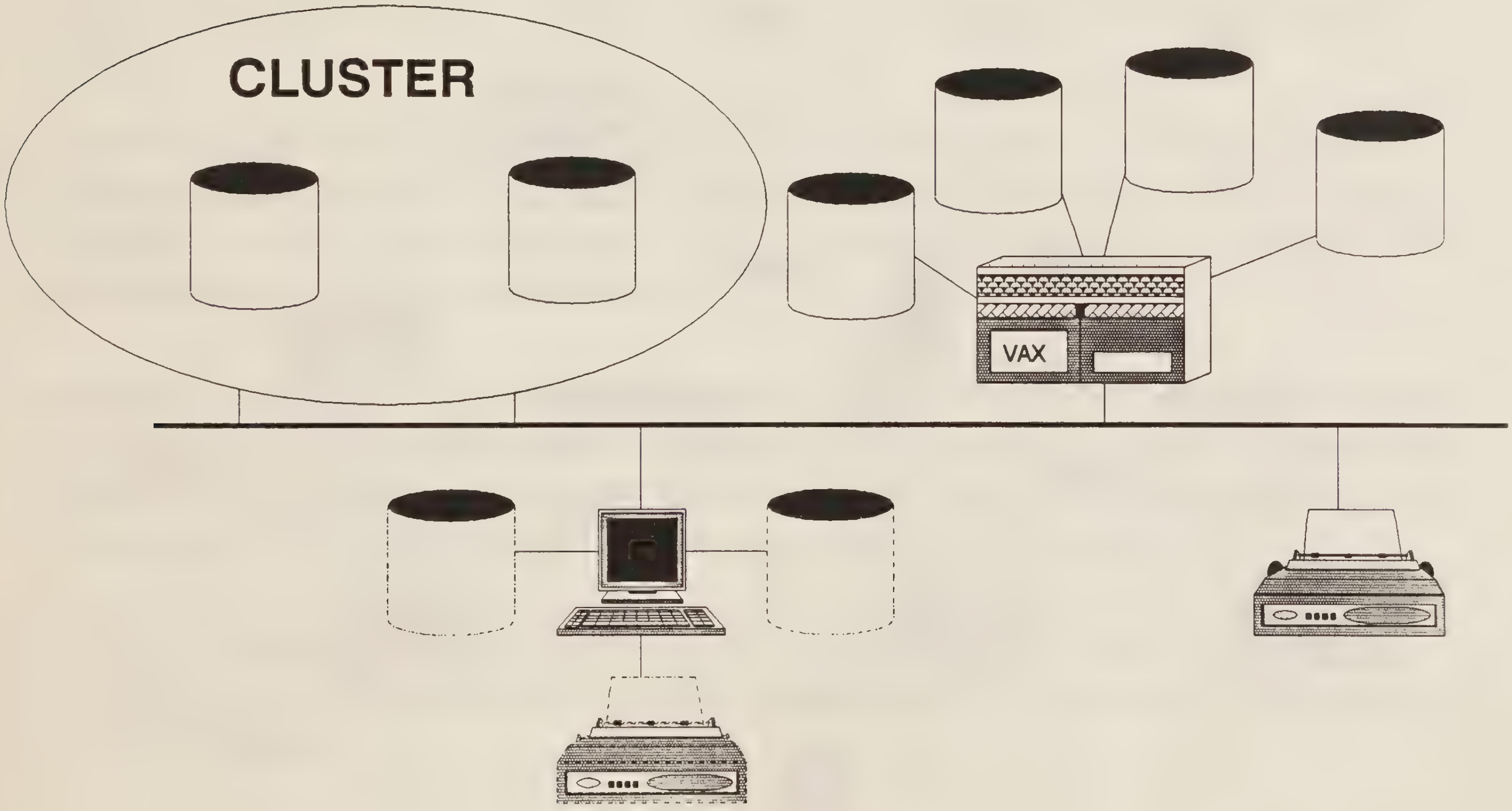
- Distributed File System make remote directory structures appear as local to the user node. Can use DFS in place of DAP. In a high bandwidth environment such as Ethernet, DFS is an order of magnitude faster than DAP services. A remote file system is made available via a mount point which has the same syntax as a device name (DFS1:filename).

- DFS is somewhat similar to the Local Area VAX Cluster. The difference is that DFS works for all nodes on the network where a LAVC can only have 26 nodes. The LAVC has an advantage of tighter locking and a unified security and management domain.



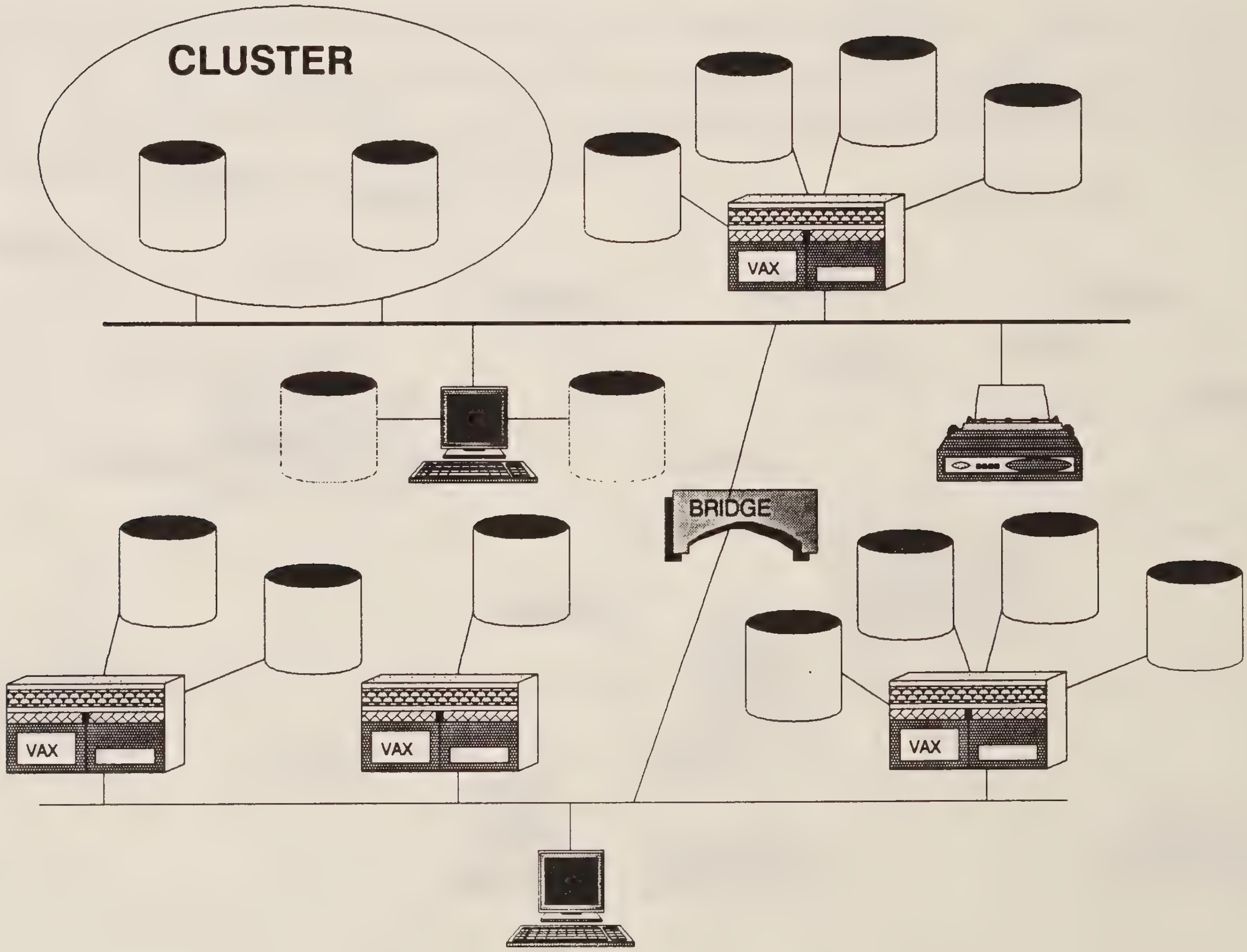
Distributed Queuing Service

- A Distributed Queuing Service (DQS) provides remote printing capability in a network. Uses the client/server configuration. Client requests a print operation. The job is queued to a print server for processing. With DQS, the print server can be across the room, down the hall, or on the other side of the world.



Remote System Manager

- Remote System Manager (RSM) provides tools for the centralized management of a distributed environment. Includes an installation and management menu interface. System manager can define a group of remote nodes as a single management domain. Commands will affect the domain as if it were a single system.



Network Virtual Terminal

- Associated with the broader Terminal Software Architecture which defines a broader class of terminal services.

- Allows a DECnet host to manage a terminal its own way, regardless of the operating system on the server.

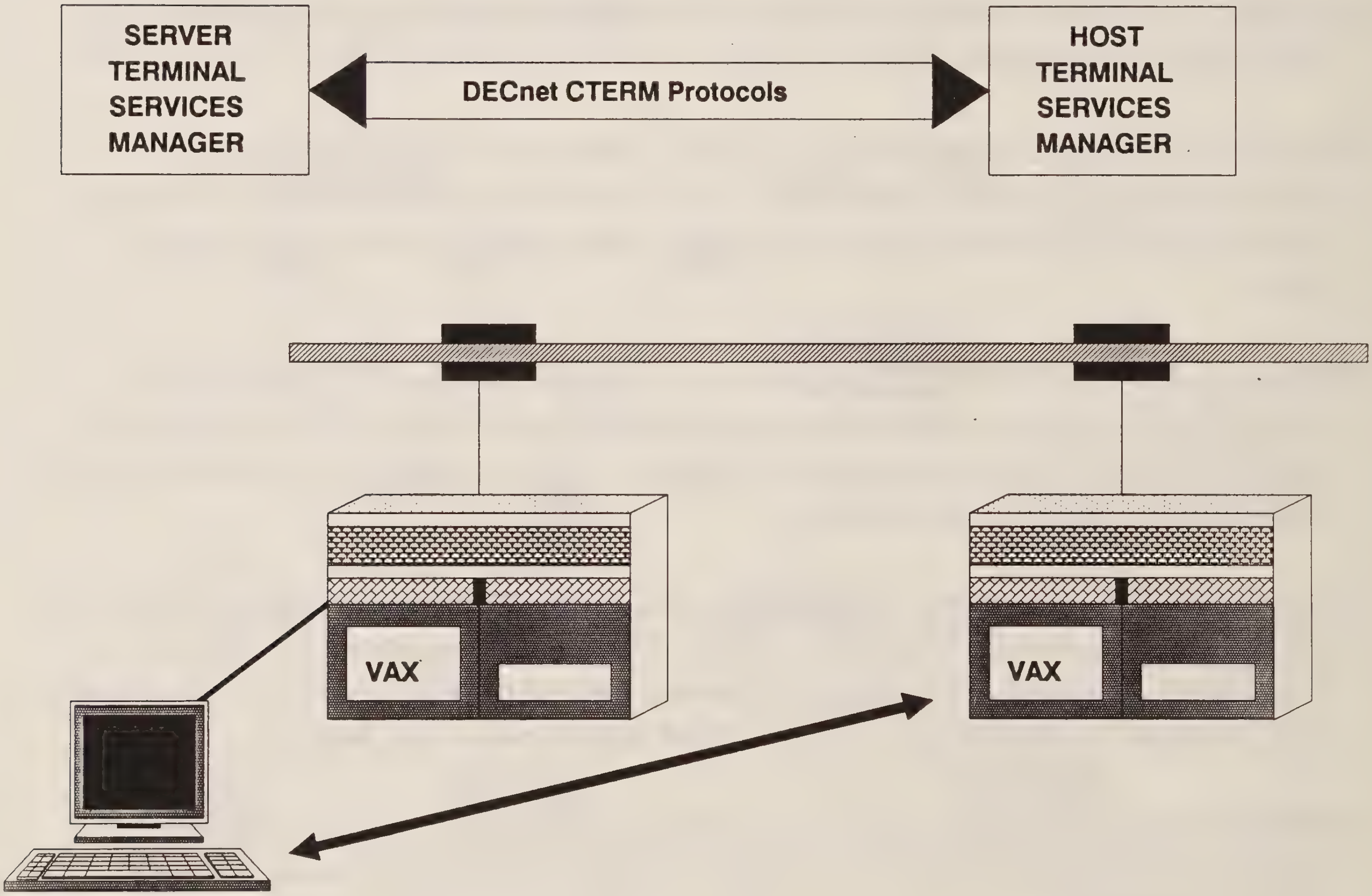
- Within the Network Applications Layer, there are two layers of the network Virtual Terminal Service. The Terminal Communication Module is the foundation layer. The Command Terminal Module is the upper layer.

- The terminal communication protocol is responsible for making and breaking connections between applications and terminals. Extends the Session Control layer services to set up a logical link to an endpoint with terminal-specific characteristics.

- Usually, an application issues requests to the command terminal module on the host system. These are sent to the command terminal module on the server process. The server process can send out-of-band data (such as a control/Y) which bypass the input and typeahead buffers.

- CTERM messages allow querying of size of buffers, clearing buffers, reading and setting terminal device characteristics and read and write data to devices.

CTERM Protocol



SERVER TERMINAL SERVICES MANAGER

DECnet CTERM Protocols

HOST TERMINAL SERVICES MANAGER

Layer 7: Network Management Layer

- Network Management modules actually reside in several different layers. The user interface to the Network Control Program (NCP) is in the User Layer. The modules collect information from lower layers.

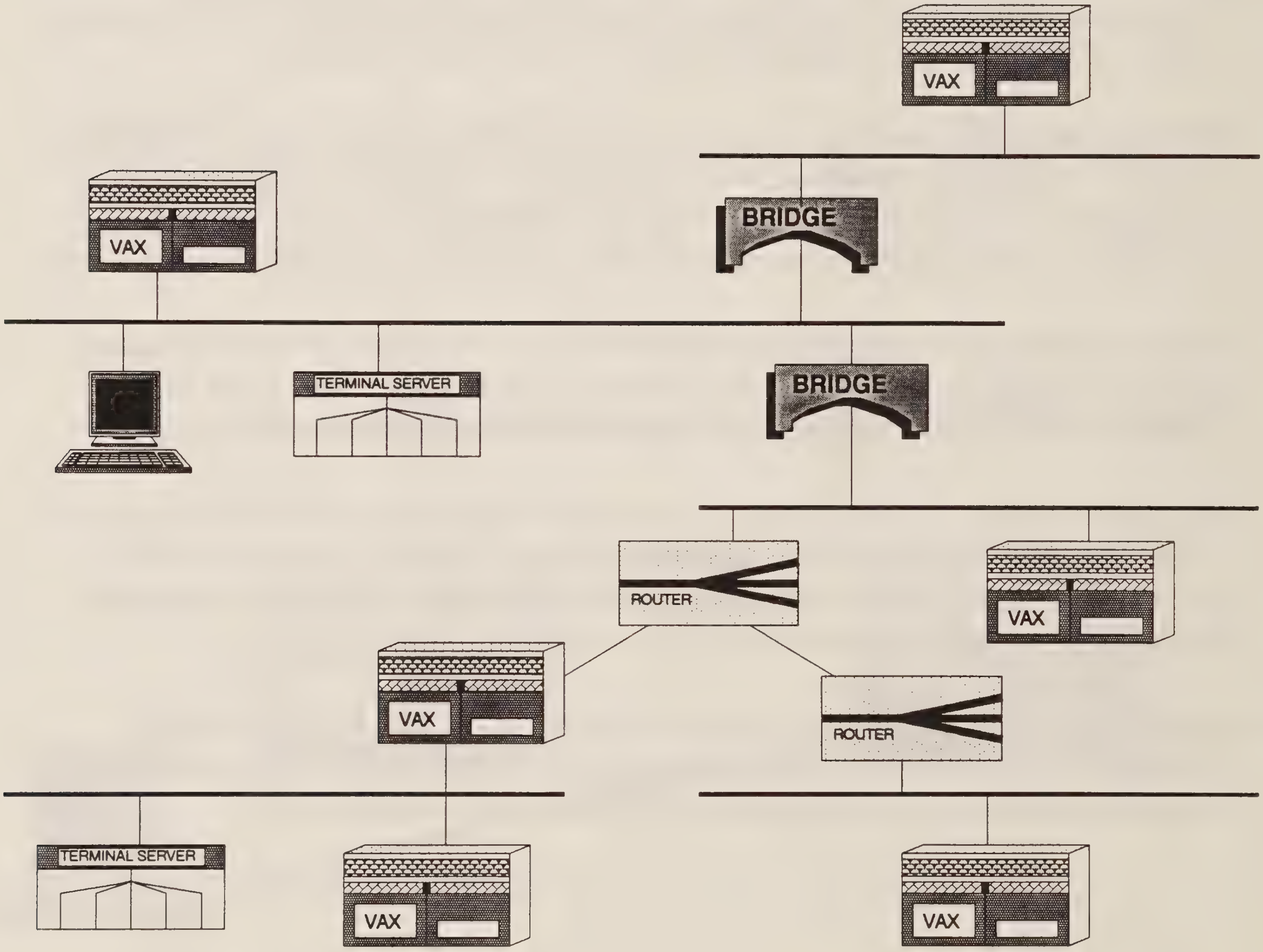
- Network Management is conceptually very difficult because of the sheer number of devices involved. Performance management, system configuration, security, accounting, and managing user accounts all increase in complexity over detached systems by an order of magnitude.

- Network Management Access Routines communicate across a logical link to a Network Management Listener on another node. That node passes information requests to Local Network Management Functions.

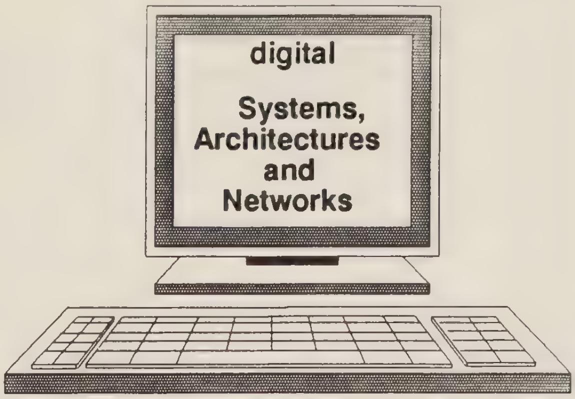
- An Event Logger in the Network Management layer reads event queues and logs that information. An Event Logger protocol specifies which events to log and sends the information in a raw state (no processing occurs) to a specified sink node or console.

- Examples of logged events for the routing layer could include lost packets, unreachable nodes for packets, oversized packet errors, circuit failures, and failures to properly initialize at a remote node.

Network Control Program



DIGITAL NETWORK ARCHITECTURE



Key Concepts in This Section

- DNA is a seven layer architecture. All user applications and interfaces are above the seven layers. Nodes on the network are either end nodes or routing nodes. Examples of end nodes are PCs and Ultrix nodes.

- DNA supports three data link protocols.

    > DDCMP is used for point to point links in either synchronous or asynchronous modes.

    > X.25 is used for wide area networks.

    > Ethernet is used for local area networks.

- Routing in DNA is adaptive to topology changes but not to congestion. There are up to 1023 nodes in an area with up to 63 areas in a DECnet.

- Major network services are the Virtual Terminal and the Data Access Protocols. DAP protocols usually extend the local Digital Command Language across the network by starting a File Access Listener process on remote nodes.

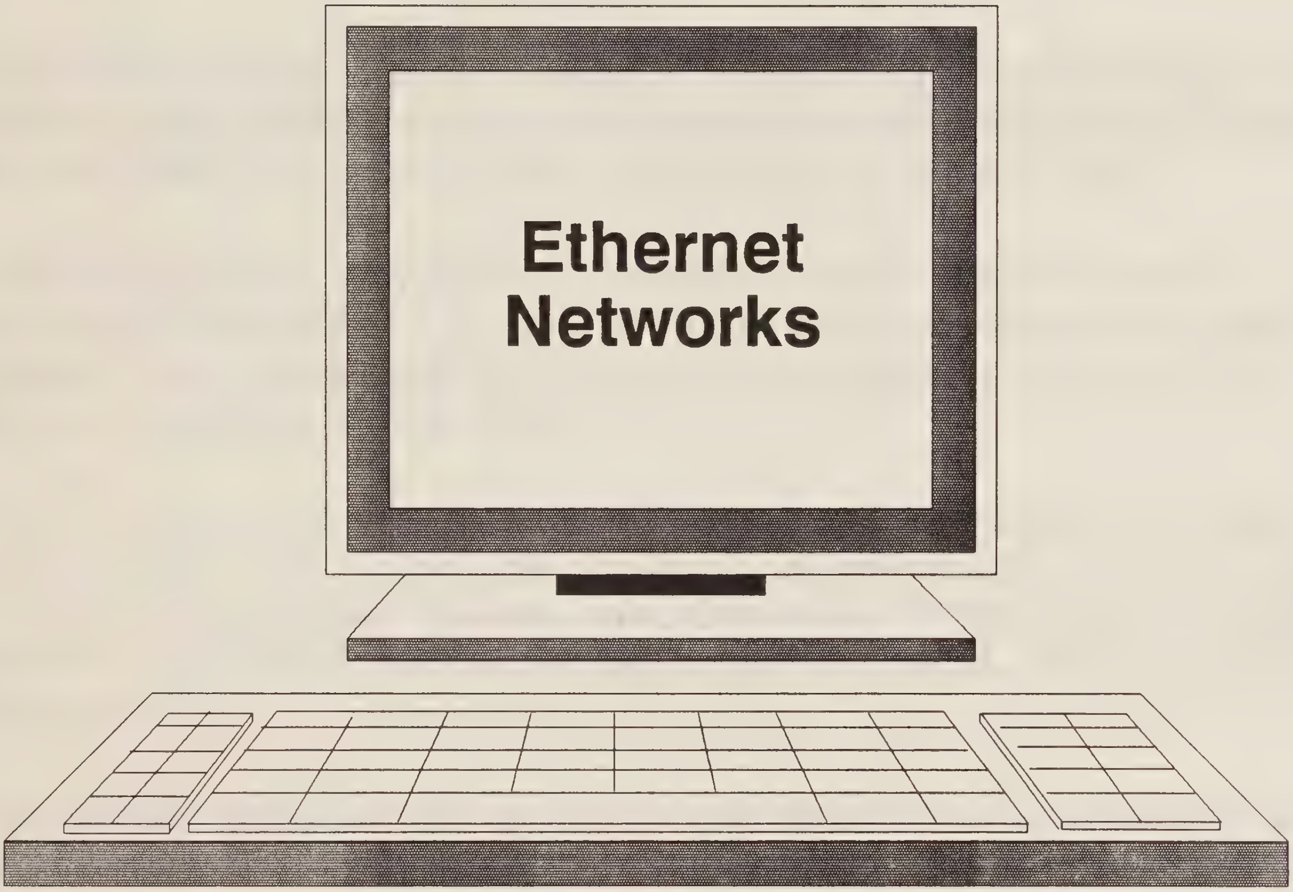
- DSS is an emerging family of products that allow you to better operate in a distributed computing environment.

"Experience is the name we give to our past mistakes."

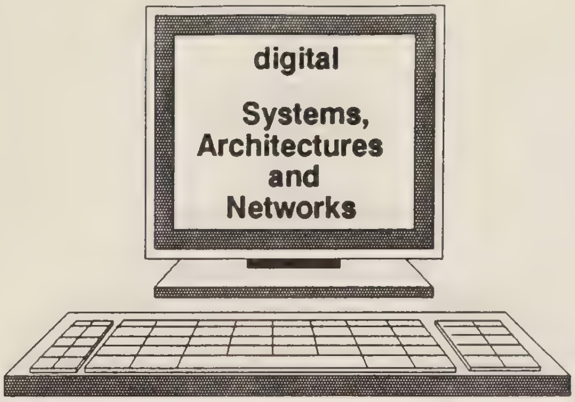
Oscar Wilde

"Policy is the name we give to our future mistakes."

Henry Wallich, former Federal Reserve governor


Ethernet
Networks

ETHERNET NETWORKS



Overview

- Ethernet is a broadcast-type network. The Ethernet data link protocols shield the DNA routing layer from the type of media being used. Ethernet can use COAX cable, CATV cable, twisted pair,or optical fiber.

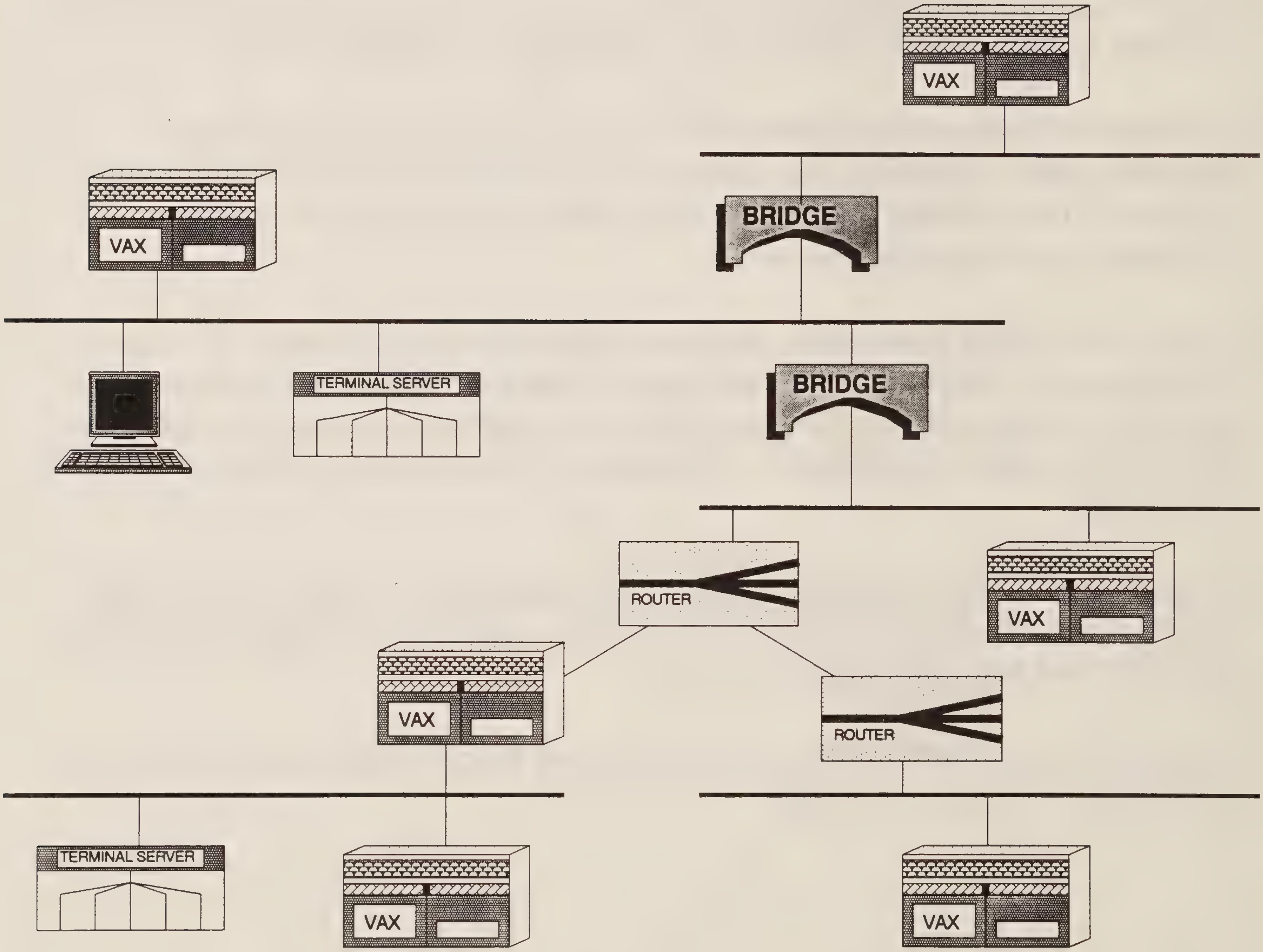
- A physical Ethernet may consist of several pieces of cable linked together with repeaters. The Ethernet looks like one cable to the nodes involved. The routing layer of DECnet still regards all nodes on the Ethernet as being one hop away.

- If the limit of one Ethernet is reached because of the number of nodes, the amount of traffic or the distance involved, an extended Ethernet can be made using bridges. The extended Ethernet still looks like a point to point link to the routing layer: all nodes on the extended Ethernet are one hop away.

- Routers are used to offload routing functions from VAXes. Routers can connect many Ethernet segments together, as well as other nodes of the network that are not on an Ethernet.

- Terminal servers offload terminal functions from VAXes just like routers offload the routing functions.

Local Area Networks (LANs)



Ethernet Layers

- Ethernet deals ONLY with layers one and two of the ISO Reference Model. A variety of upper layer protocols may run on this Ethernet. Example of upper layer protocols include:

  > Digital Network Architecture (DECnet)

  MOP

  > Local Area Transport (LAT)

  > System Communications Architecture (SCA)

  > TCP/IP

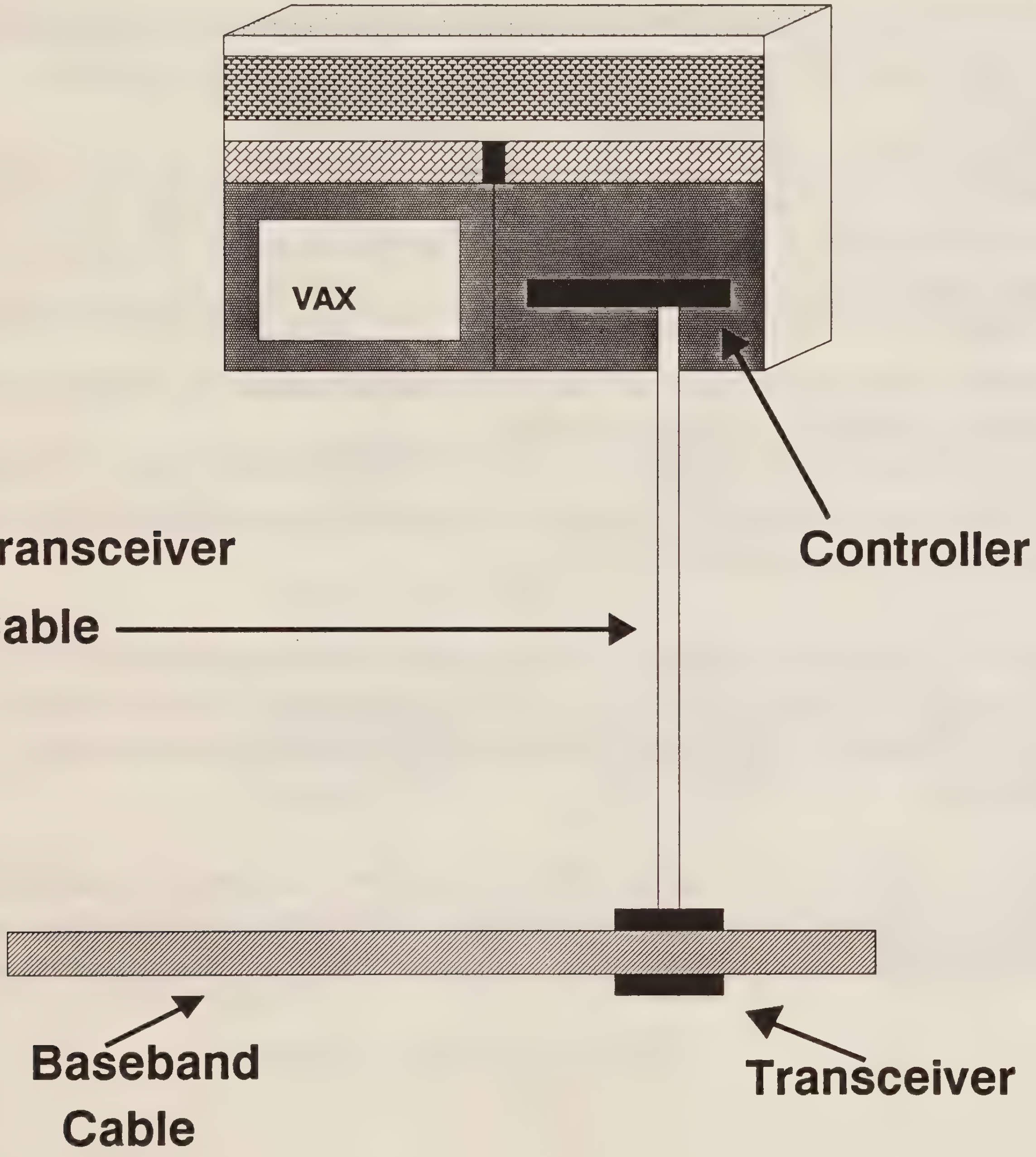
  > XNS

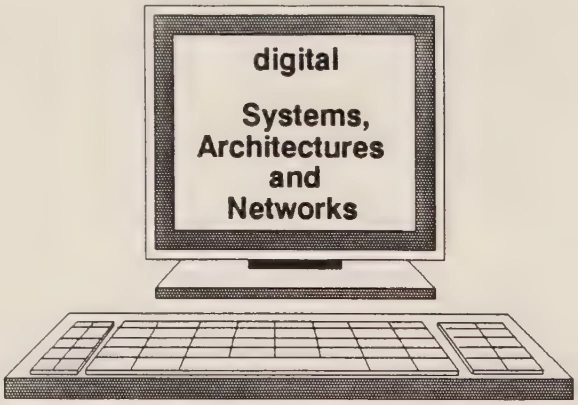
- All of these different network architectures can be co-resident on one Ethernet cable.

Baseband Ethernet

- A controller is the interface device between the computer and the network itself. Which device you use depends on the peripheral bus.
  - > Unibus = DELUA
  - > BI bus = DEBNA DEBNI on 9000's
  - > IBM PC = DEPCA
  - > Q-bus = DELQA or DESQA
  - > MicroVAX 2000 = DESVA
- A controller is network media independent. Thus, the same controller is used for all three current Ethernet media (baseband, broadband, thinwire). A controller can connect to only ONE network. However, a given computer may have several controllers.
- A transceiver is used to make the connection to the transmission media. Transceivers are media dependent. An Ethernet transceiver handles carrier detection and collision detection (Layer 1 of the model). The DEC H4000 transceiver uses a vampire tapping method into the media. The H4005 is non-intrusive.
- A transceiver cable connects the transceiver to the controller. A Baseband transceiver cable may be up to 50 m long.

Baseband Components





Broadband Ethernet

- DEC DECOM serves the same function as the Baseband-equivalent H4000. Both can use the same transceiver cable and controller.

- DECOM-BA works for single cable Broadband networks. Transmits at 54 to 72 MHz and receives at 210.25 to 228.25 MHz. Note that single cable Broadband networks require the DEFTR at the headend to convert from transmit to receive frequencies.

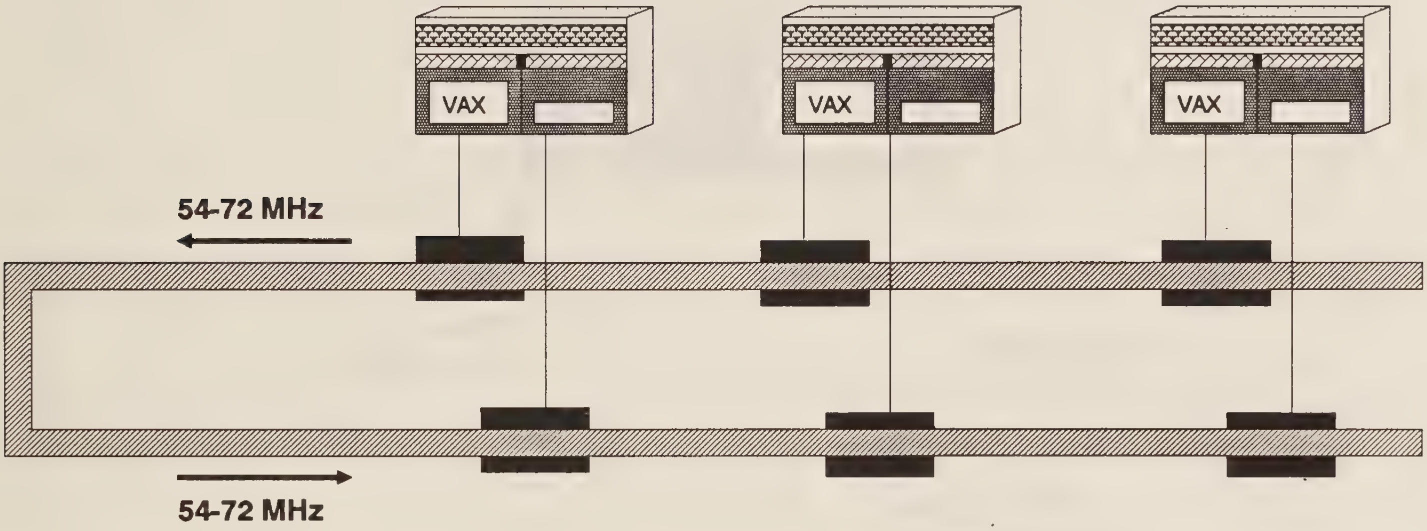
- DECOM-AA works with dual cable Broadband networks. Because of the dual cables, the DEFTR is not needed.

- CHIPCOM makes another Broadband Ethernet transceiver that is NOT COMPATIBLE with the DEC DECOM.

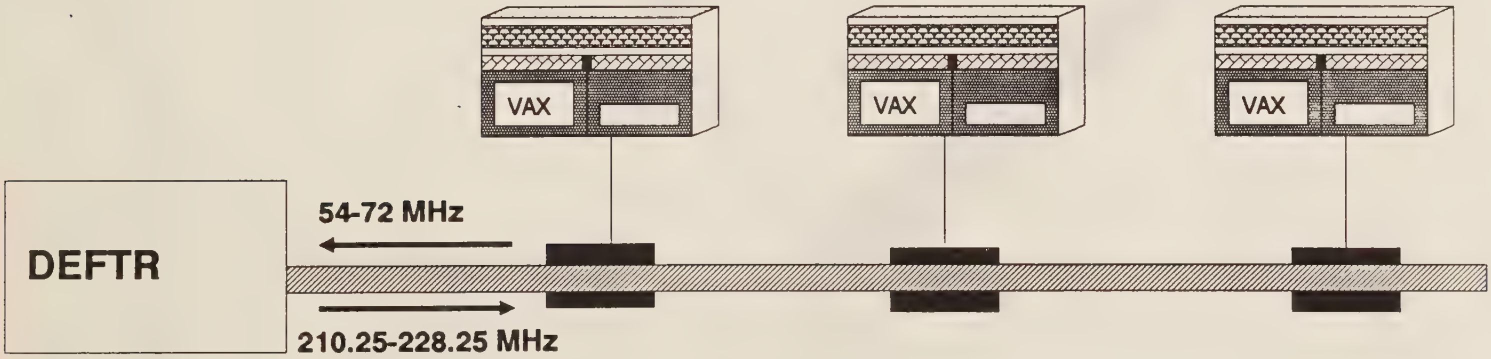
- Broadband Ethernet Frequency Translators (DEC's product is the DEFTR) work on single cable Broadband systems. They translate incoming signals and retransmit them at the appropriate receive frequencies.

- Broadband systems can have different devices sharing the bandwidth. A CATV cable has sufficient bandwidth for many different subchannels. A CHIPCOM system may run on one frequency and a TV station on another.

Broadband Cabling Configurations

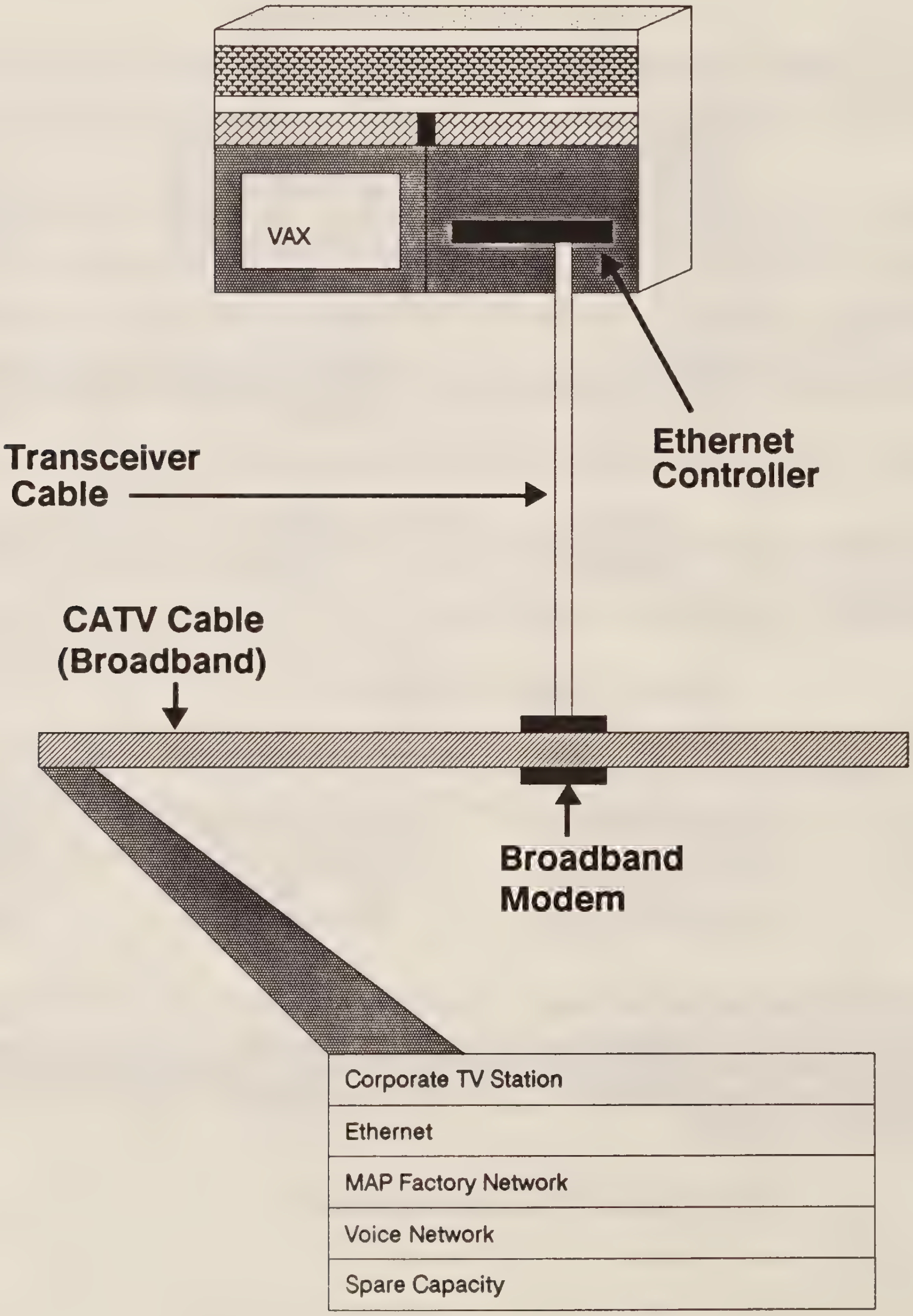


Dual Cable Broadband

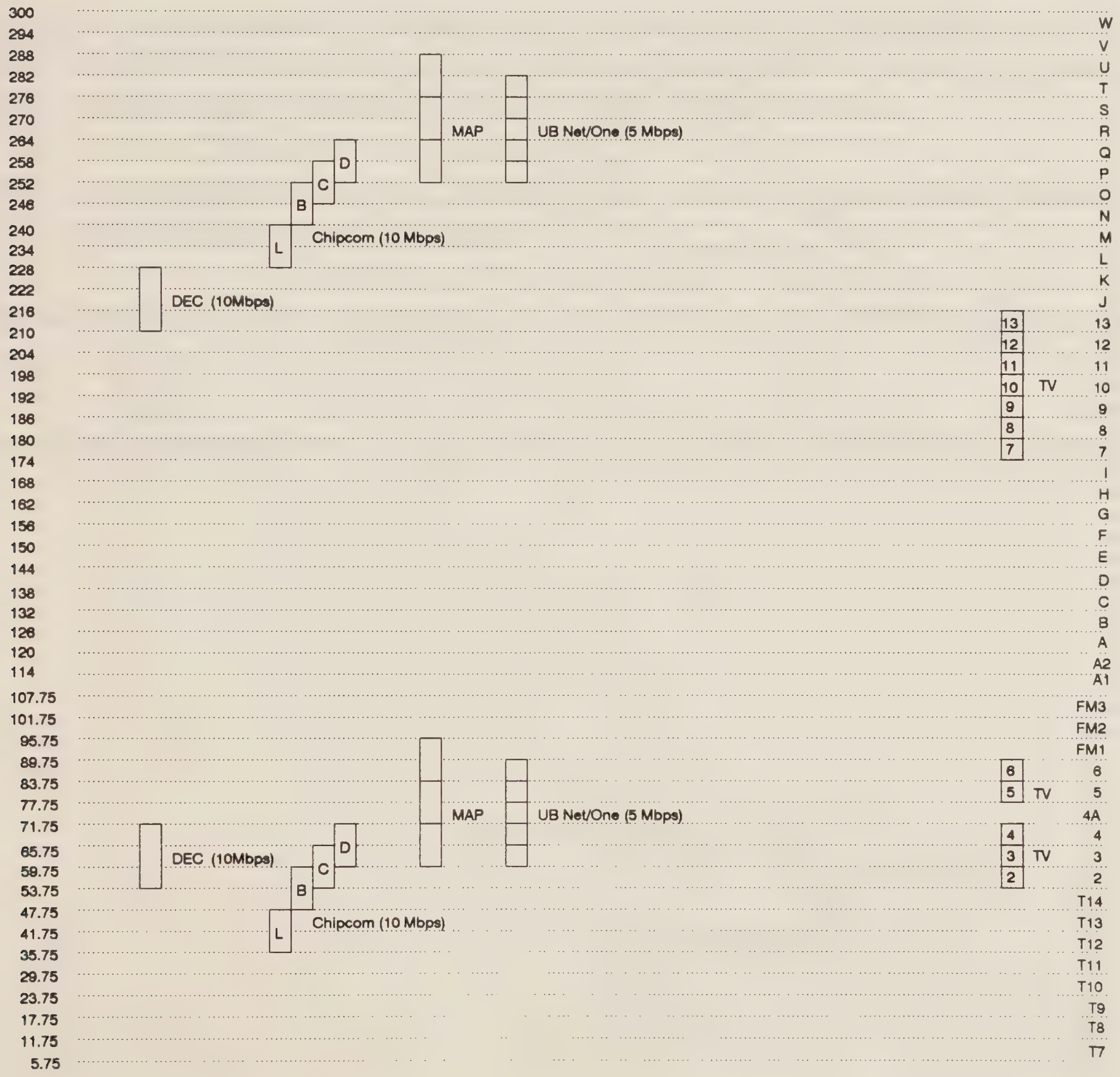


Single Cable Broadband

Broadband Advantages

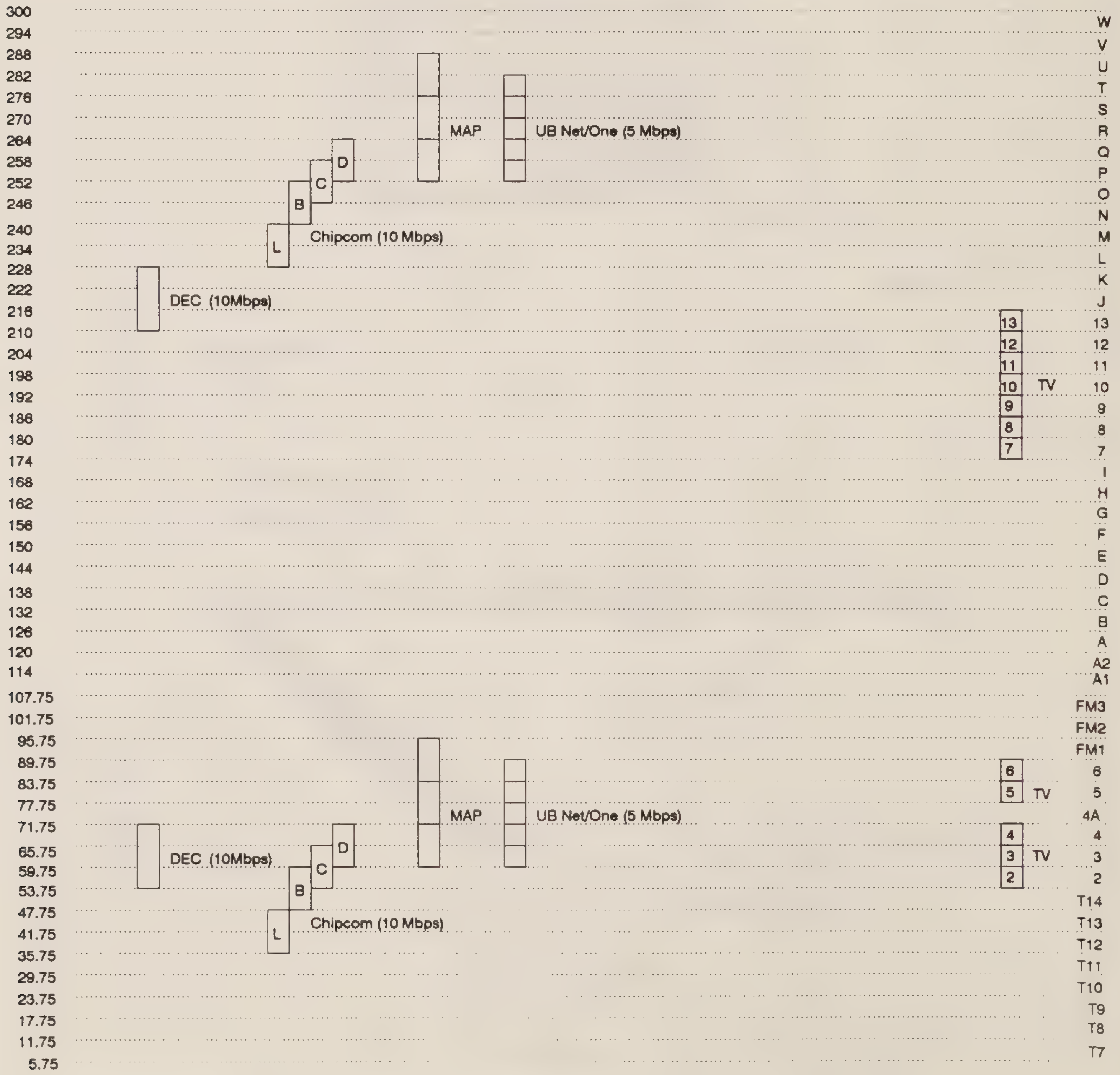


Broadband Frequency Spectrum



Broadband Freguency Spectrum

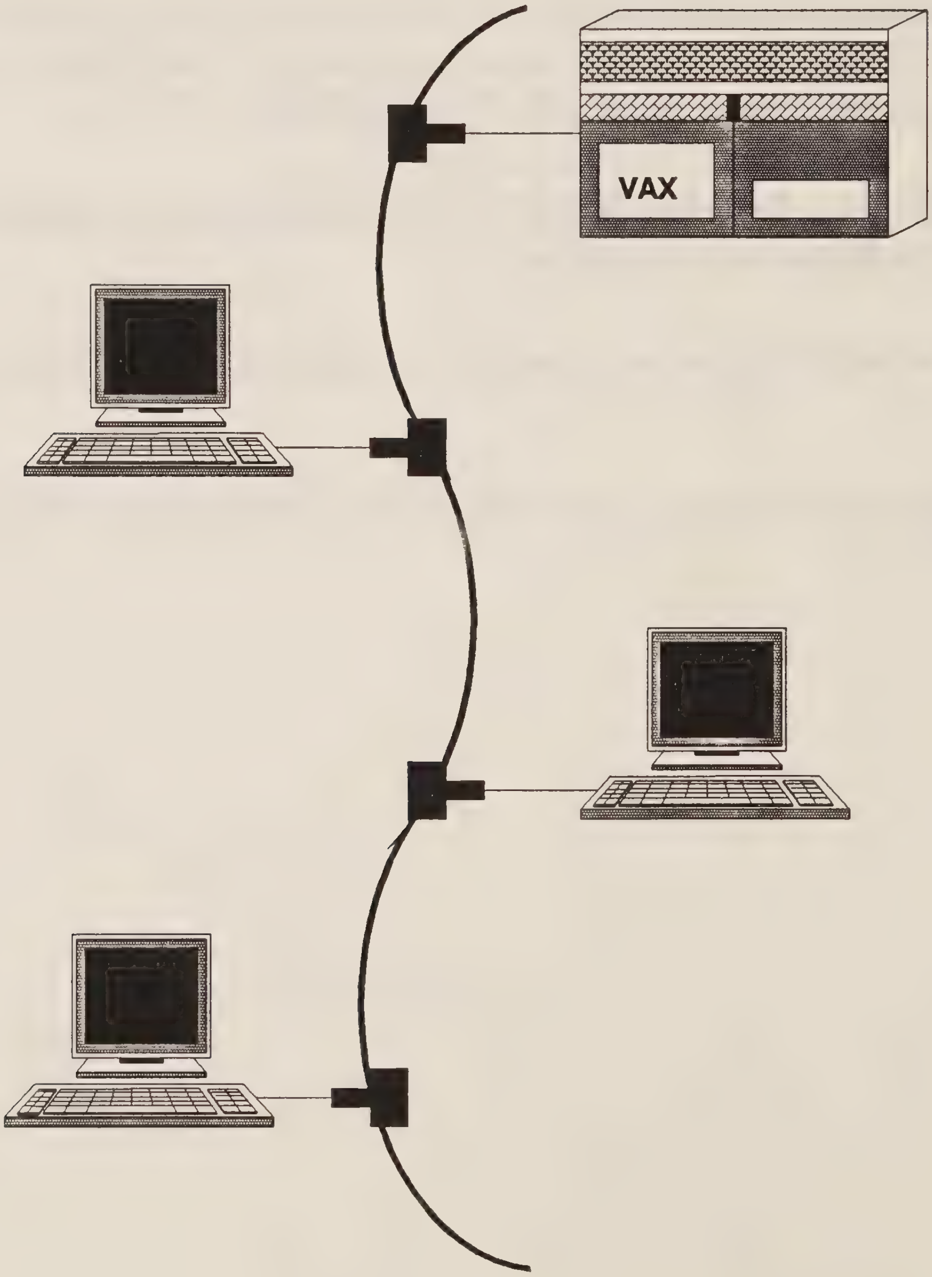
missing Something?



Thinwire Ethernet

- Thinwire, also known as Cheapernet, is cheaper than baseband and often used in a work area, such as a Local Area VAX Cluster or a network of PCs. It is usually used only with PCs and MicroVAXes.
- DEC uses a Station Adapter (DESTA) as a thinwire transceiver. Takes power from the Ethernet controller.
- Thinwire Ethernet transceivers require you to cut the cable to add a new node.
- Thinwire segments may be up to 185 m long with a total of 30 stations.

Thinwire Connections



Optical Fiber Ethernet

- Fiber has been used by DEC as a method of connecting different segments of COAX together. When used as a method of interconnection, individual nodes are not connected to the fiber.

- Fiber is used in critical security environments such as military applications. This is because fiber does not emanate signals as COAX does.

- Fiber is inherently a unidirectional type media. It is possible to build a CSMA/CD fiber network. The hard part is getting the collision detection to work at an affordable price. Thus, fiber is most often used as a point-to-point media.

- Because fiber is unidirectional, fiber optic cable contains two fibers. One marked INPUT, the other marked OUTPUT.

Fiber Distributed Data Interface (FDDI)

- An emerging standard based on a token ring architecture, dual optical fiber rings and 100 Mbit/s network. Can provide a high-speed backbone used to connect to Ethernet or other lower speed LANs.

- DEC has announced FDDI support as a backbone technology with continued emphasis on Thinwire and Baseband within a work area.

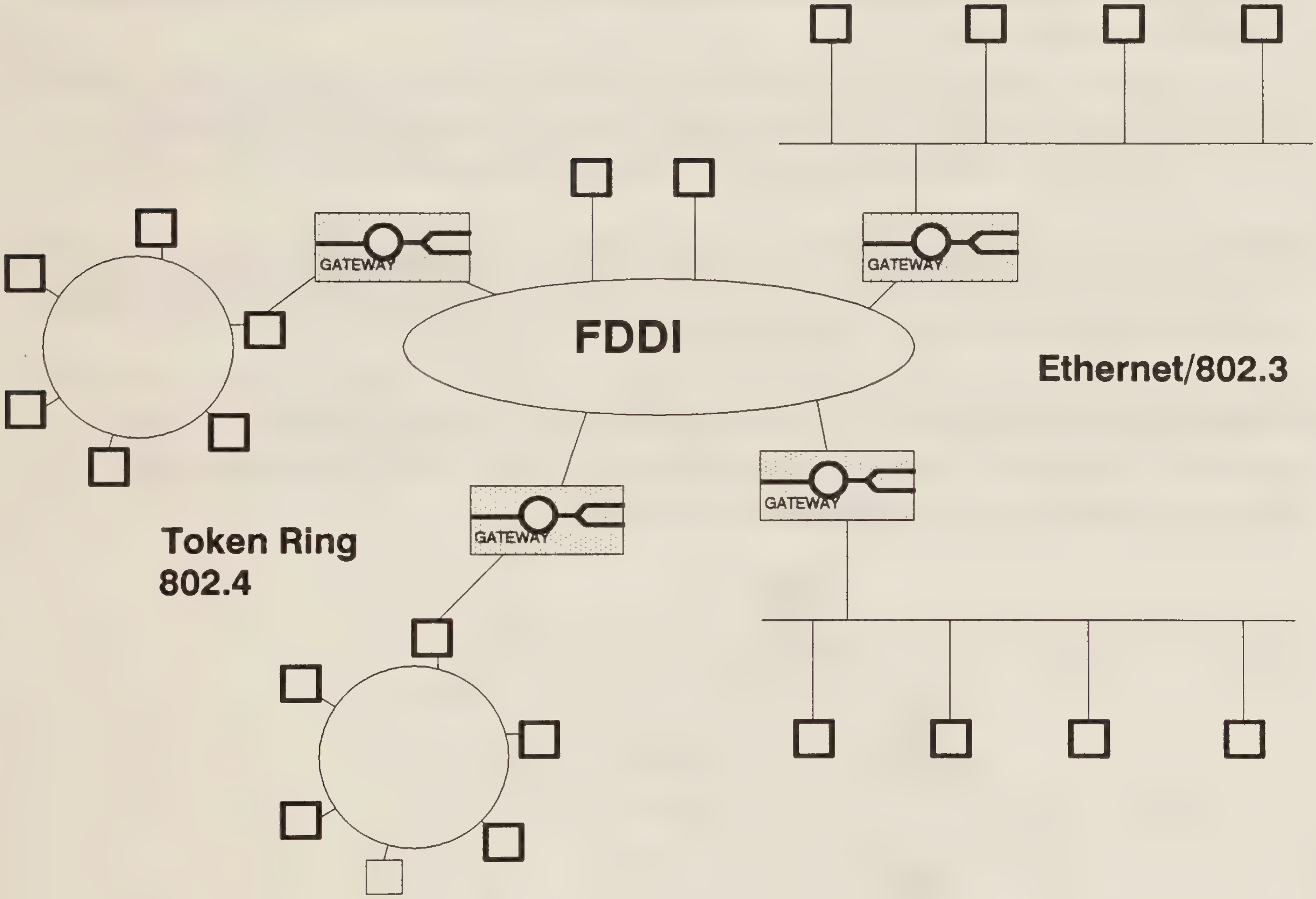
- The basic FDDI protocols are simular to 802.5 protocols (token ring). Major differences being that a FDDI station may put a new token on the ring when it finishes.

- FDDI calls for a 100 Mbit/s speed, a 200 km length, and up to 1000 connected stations.

- Expect the first FDDI-compliant products by early 1990. Several companies are now marketing a FDDI-like product. Artel Communications is one such company. Caveat emptor.

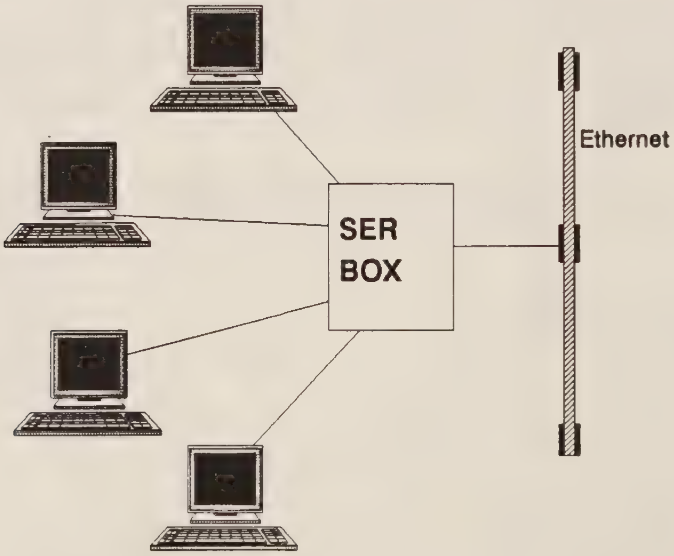
- FDDI-II, an extension of FDDI, will be able to handle voice or data.

FDDI Backbone



Twisted Pair Ethernet

- Several companies, including DEC and AT&T, support Ethernet over twisted pair wires. This allows existing wiring in buildings to be used for networking purposes.
- A twisted pair is two insulated copper wires. The wires are twisted to reduce electrical interference with other near-by pairs.
- DEC supports 10 Mbit/s Ethernet over shielded and unshielded twisted-pair. The maximum distance from the wiring closet to workstation is 70 meters. This is not a limitation for most offices.
- There is a growing third party support for twisted-pair products and service. SynOptics Communications offers their UTP LattisNet, with a 360 foot limitation as an alternative to DEC.



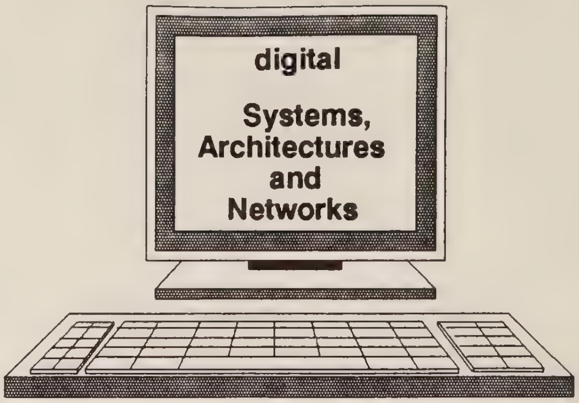
Comparison of the Different Media

- Broadband has the longest distance limitations but is expensive to install and hard to maintain. Uses standard TV technology.

- COAX (Baseband) has a fairly long distance limitation but is more expensive than thinwire. On the other hand, thinwire can only accommodate 30 nodes per segment.

- Fiber optic holds the promise of giving the advantages of both broadband and baseband.

- Twisted pair provides an easy, cheap way to hook devices up to satellite equipment rooms. Fiber or COAX would then be used as a backbone media.



Repeaters

- Single segments of COAX are limited to 500 meters (1,640 feet). Up to two repeaters may be used to make one big Ethernet network.

- Repeaters retime, amplify and repeat all signals from one segment and pass them to the next segment. A repeater works at the bit level.

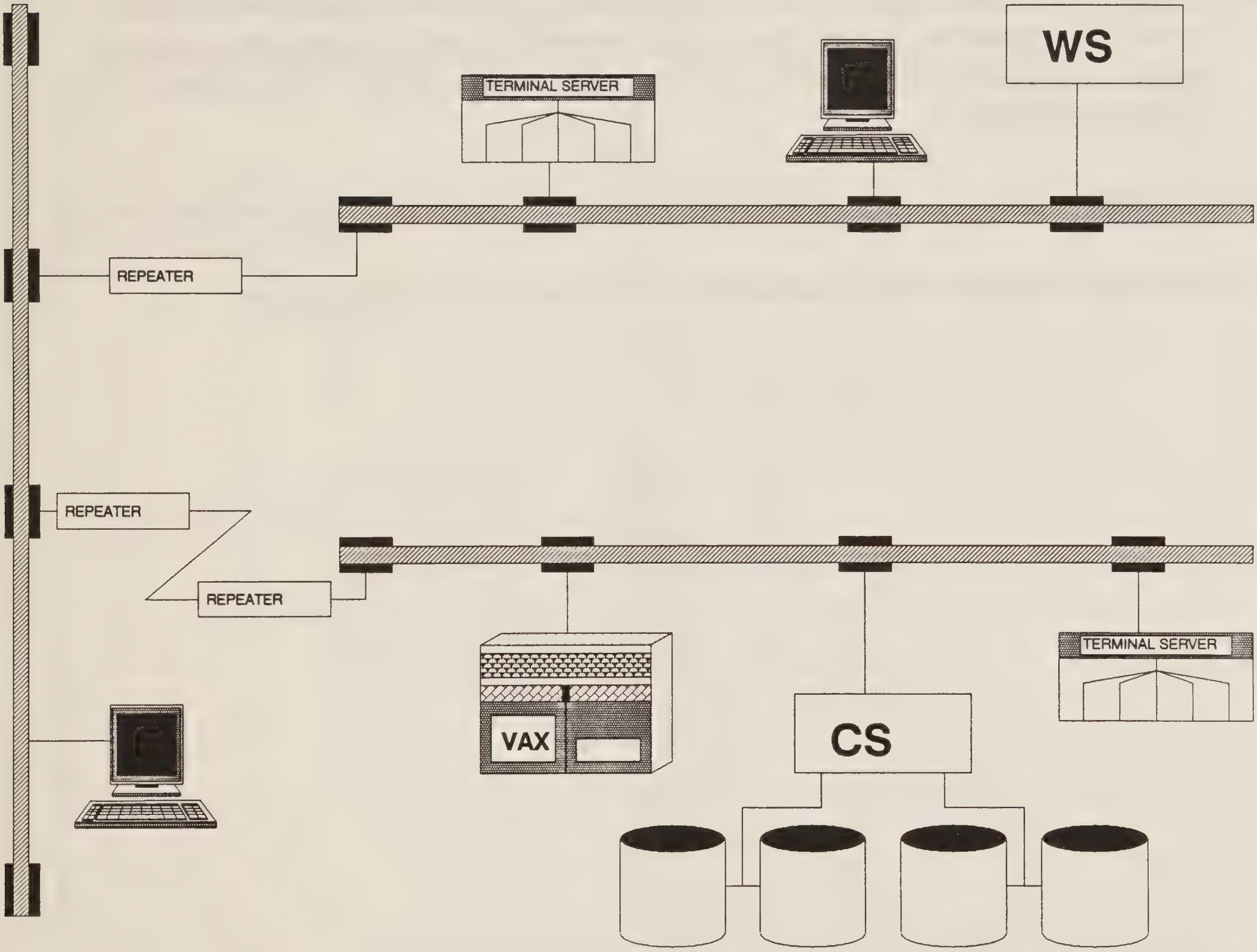
- Two versions of repeaters:

    > DEREP-AA is a local Ethernet repeater. Two transceivers are used to connect the repeater to the Ethernet. The transceiver cables are a maximum of 50 meters in length. Thus, the maximum separation between physical networks using DEREP-AA is 100 meters.

    > DEREP-RA is a remote Ethernet repeater. Remote Ethernets are connected using up to 1000 meters of fiber optic cable. You need one repeater on each end of the fiber optic cable.

- A DESPR is a special repeater used to connect thinwire segments to standard baseband Coax cable.

Using Repeaters



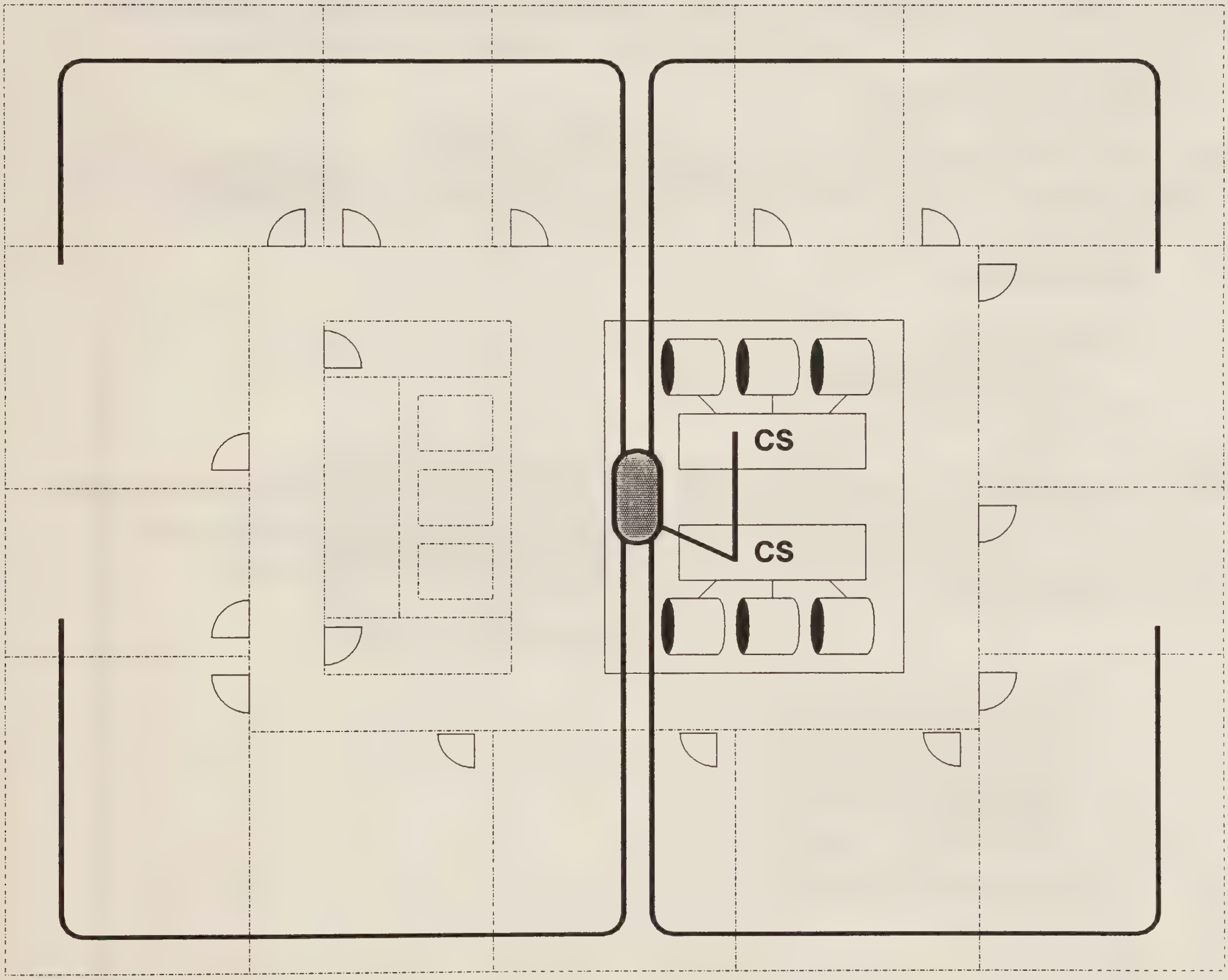
DEC Multiport Repeater (DEMPR)

- A DEMPR is a multi-ported repeater that can connect together up to 8 Thinwire segments. Most often used where there is a concentration of stations (departmental or floor). Up to 232 stations can be connected to a single DEMPR.

- A DEMPR can be used as a stand-alone device or as a connected device.

- The DEMPR counts as a repeater in the network configuration.

Using a DEMPR



DEC Local Network Interconnect (DELNI)

- Also known as "Ethernet in a can." A DELNI is often used in areas with high concentration of nodes, such as a cluster of MicroVAXes or a computer room.

- A DELNI allows 8 Ethernet compatible devices to be connected without using Ethernet cable. DELNI can be used in three configurations:

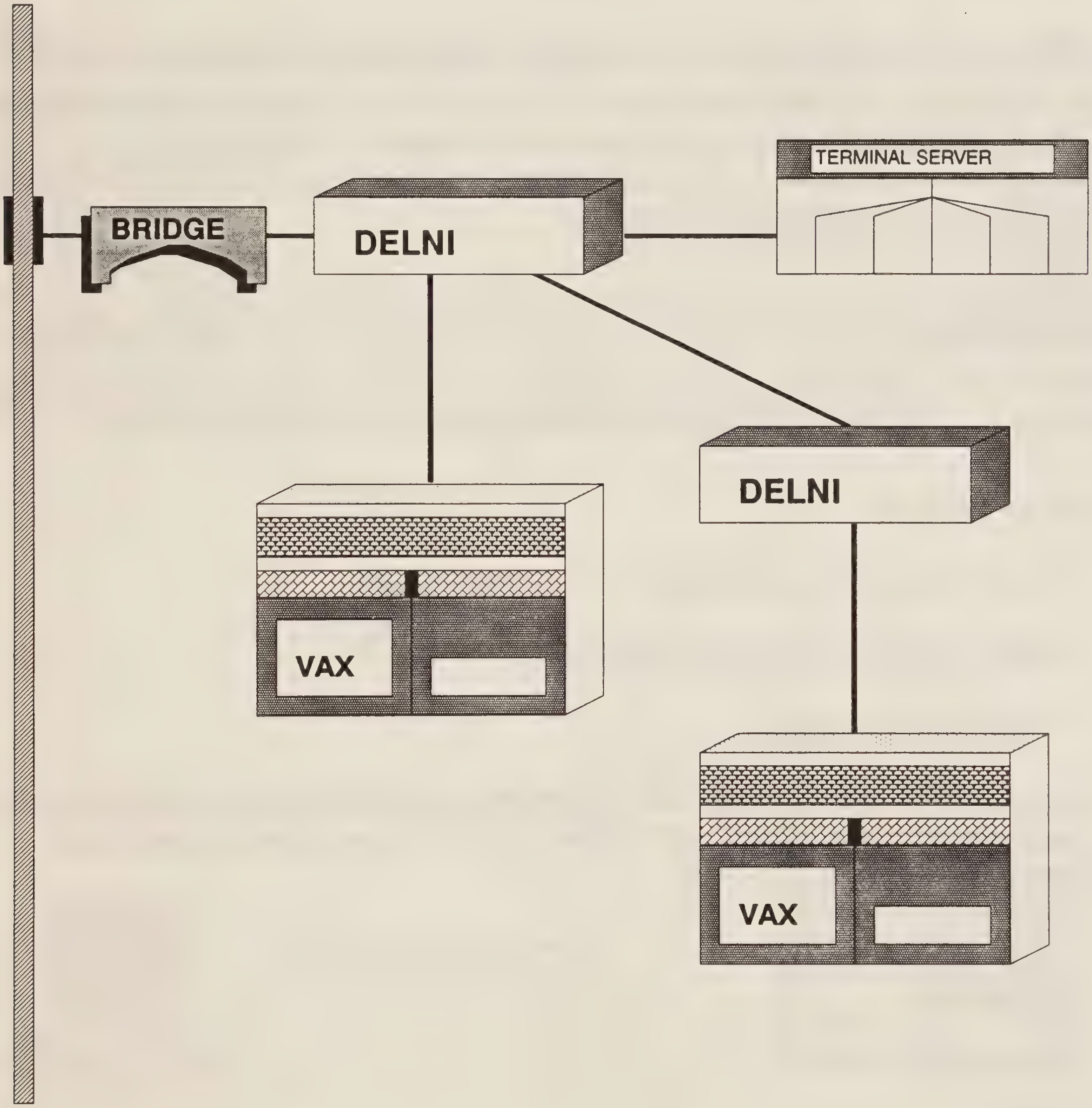
  > Stand-alone

  > Hierarchical

  > Connected

- DELNIs can serve as a security bridge. Devices on a DELNI can be taken off the global Ethernet by switching the device to stand-alone mode. A switch on the DELNI lets you choose between stand-alone and connected modes.

Using DELNIs



Extended Ethernets and Bridges

- A bridge operates at the data link layer and is independent of higher level protocols. Bridge uses store and forward to receive, regenerate and transmit packets. Maximum number of bridges is a function of time-critical protocols. DEC recommends a maximum of eight bridges if time-critical protocols are employed.

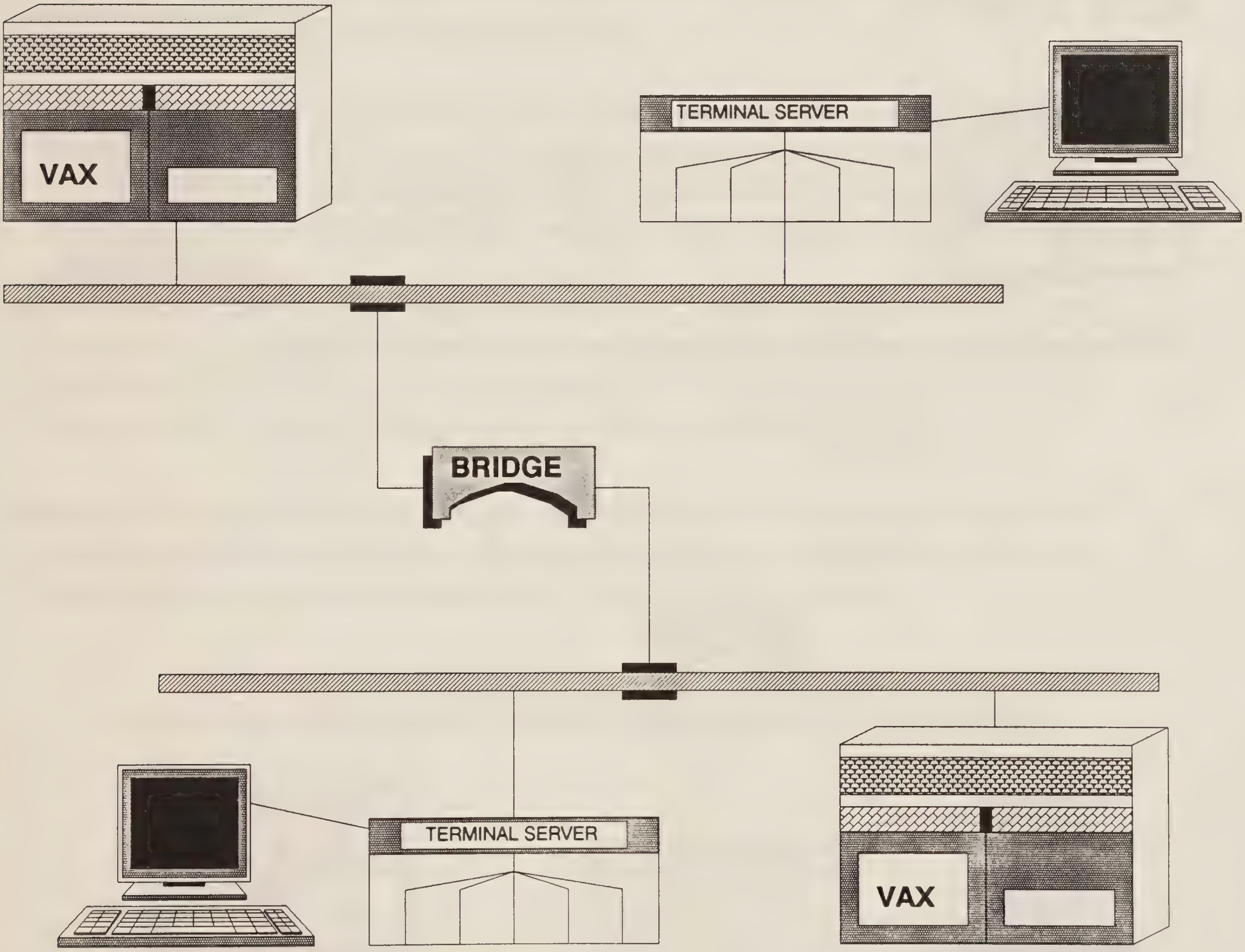
- Can place two bridges in parallel. Any bridge causing a loop automatically goes into a back-up state and takes over if the primary bridge fails. Otherwise, bridges need to be in hierarchical configuration. Bridges can also be used to connect Baseband with Broadband.

- Types of bridges:
  - > LAN Bridge 100 (DEBET)
  - > METROWAVE Bridge (DEMWB)
  - > TransLAN Bridge

- Remote Bridge Management Software allows the network administrator to manage bridges. LAN Traffic Monitor (LTM) provides a graphical interface to network analysis.

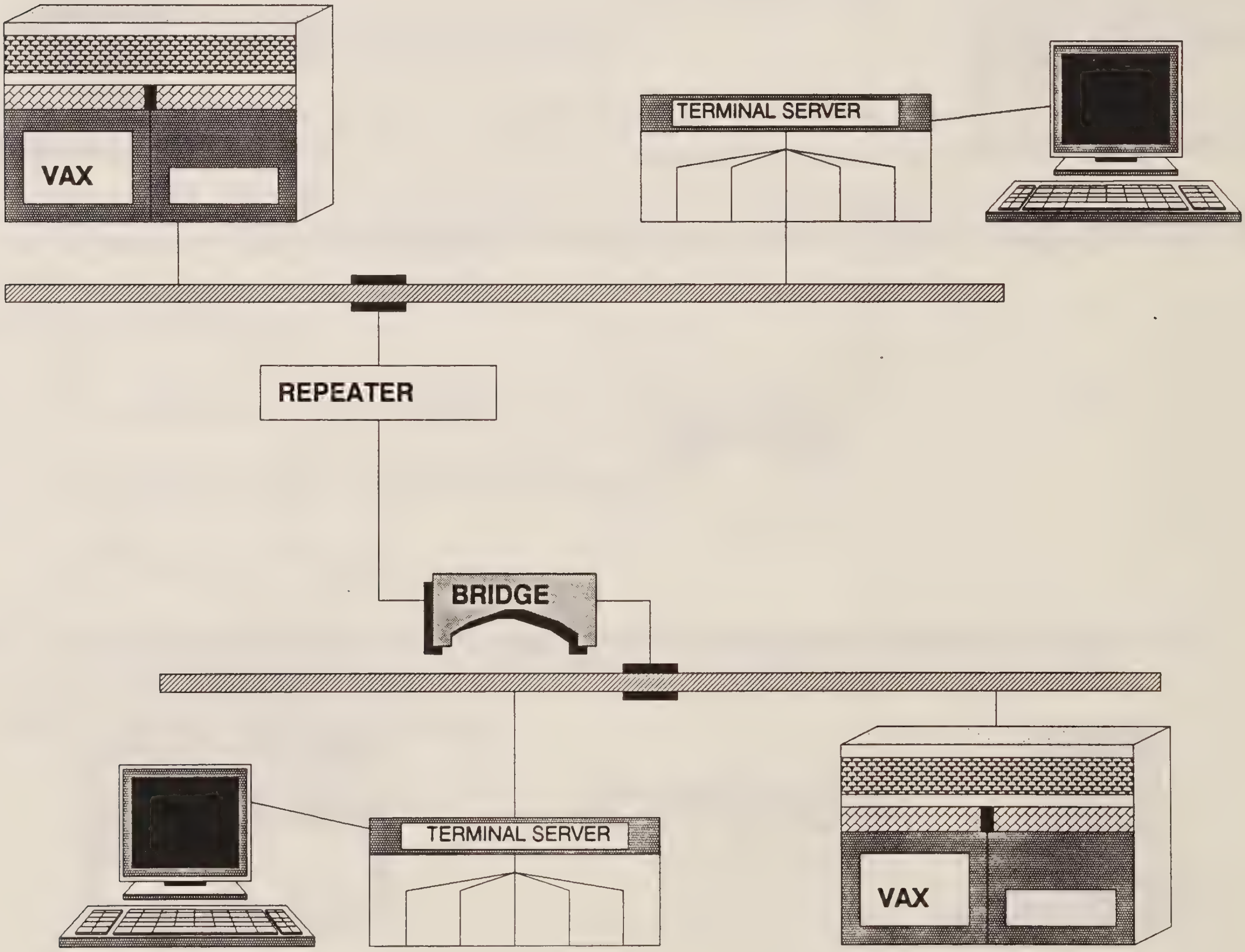
LAN Bridge 100 (DEBET-A) Configurations

- **LAN Bridge 100 DEBET-A interfaces with two transceiver drop cables.**



LAN Bridge 100 (DEBET-R) Configurations

- **LAN Bridge 100 DEBET-R (Fiber Optic Bridge) has one transceiver, one fiber optic link. If there are more than 90m between the two LANs, you need a DEBET-RH.**



Metropolian Area Networks (MAN)

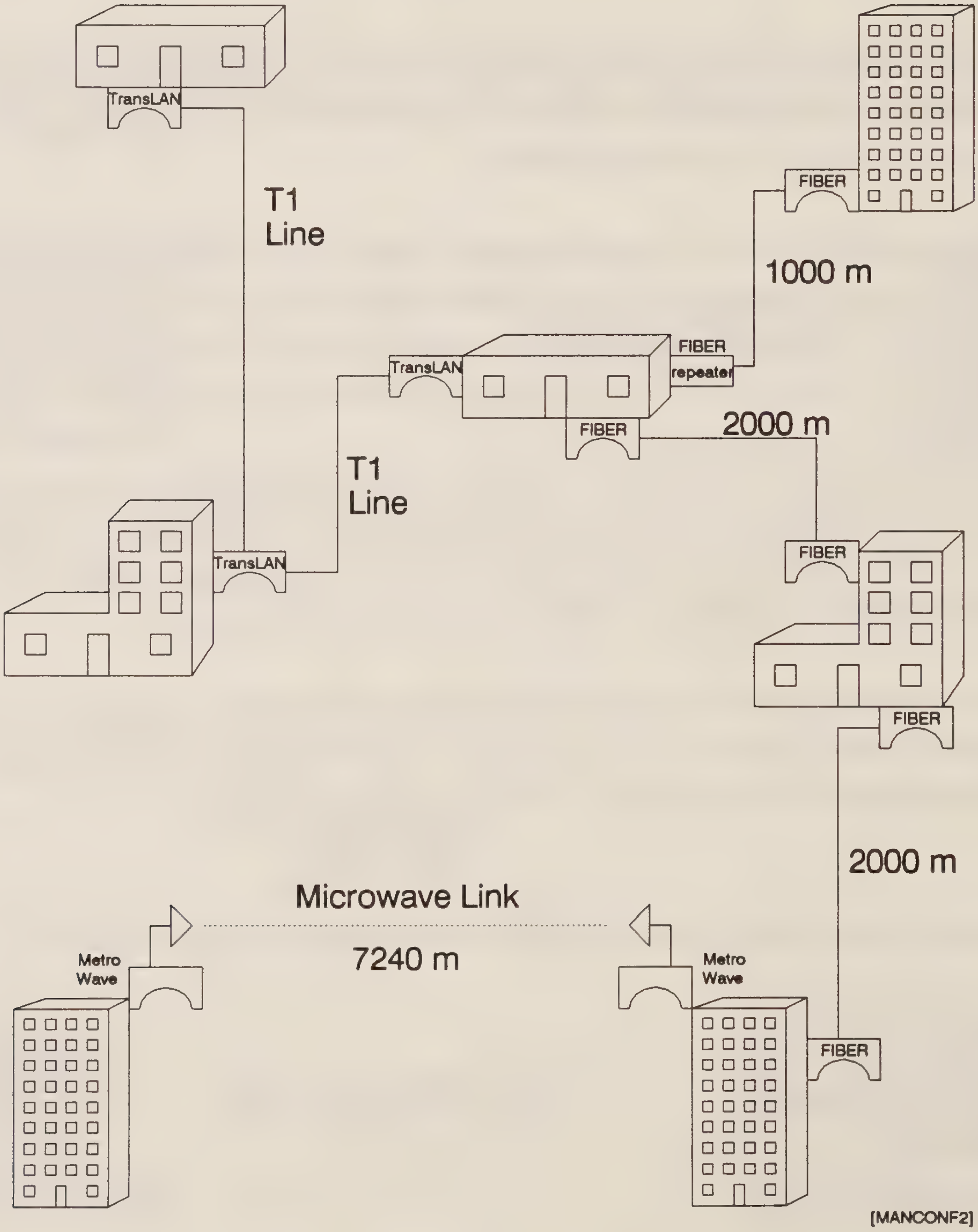
- A MAN is a network that covers an entire metropolian area. The network radius could easily extend 30 miles. Often a MAN is nothing more than the interconnecting of multiple LANs.

- The interconnect is point to point using fiber or T1 lines. Repeaters are generally not used because of the distance involved. A DECrouter 2000 could be used if connecting three or more LANs. Fiber optic bridges could be used it the distance between LANs is less than 2000 meters.

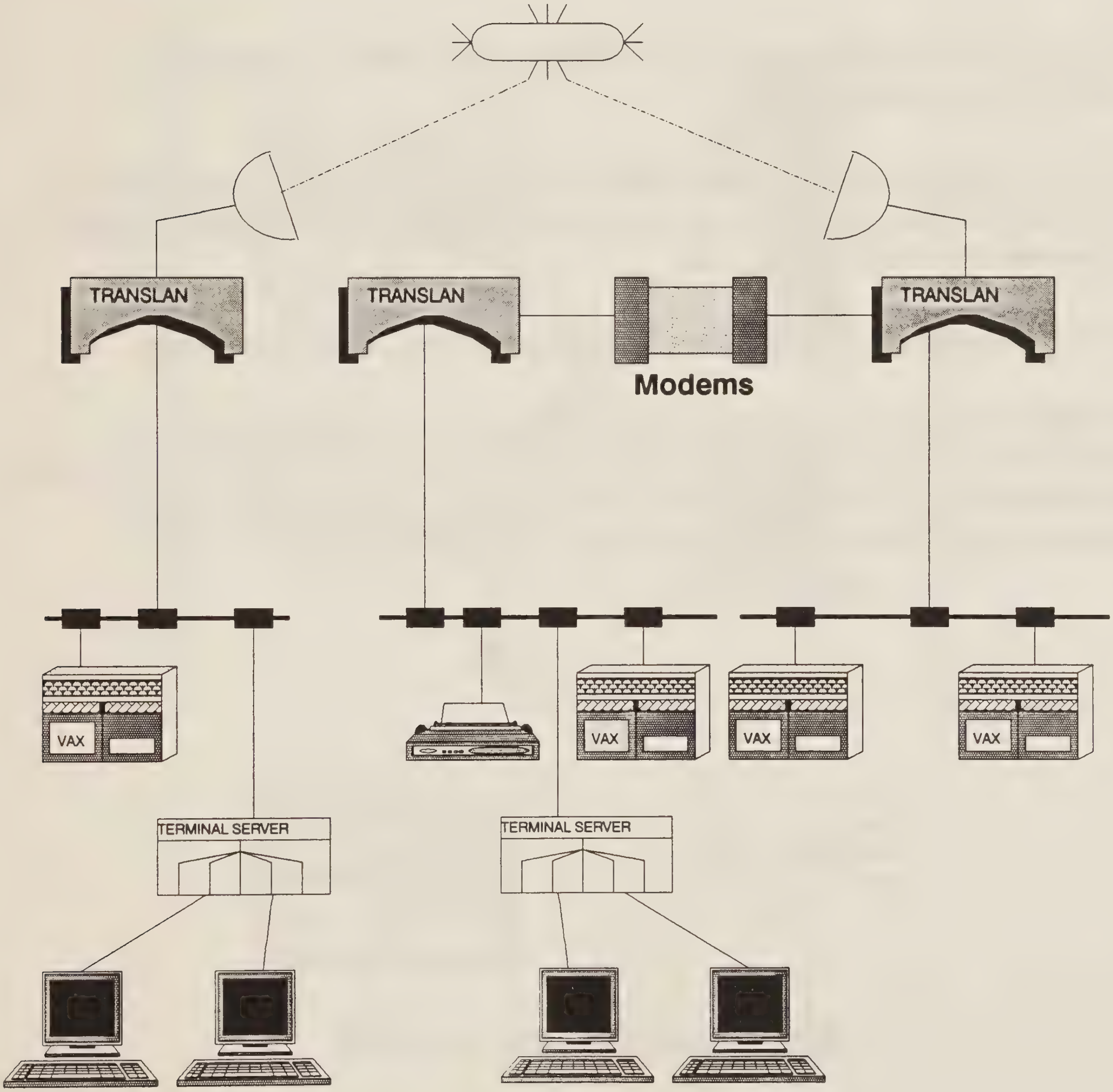
- The TransLAN bridge made by Vitalink Communications Corporation has support for satellite and common carrier links. Works with RS-232, RS-449 or V.35 connections. Multiple T1 lines are supported. The TransLAN is usually used for Wide Area Networks.

- Because the TransLAN bridge has multiple T1 lines available, it is actually performing some routing functions. Products like this are blurring the distinction between bridges and routers.

Metropolian Area Configuration



Wide Area Networks (WAN)



Routers

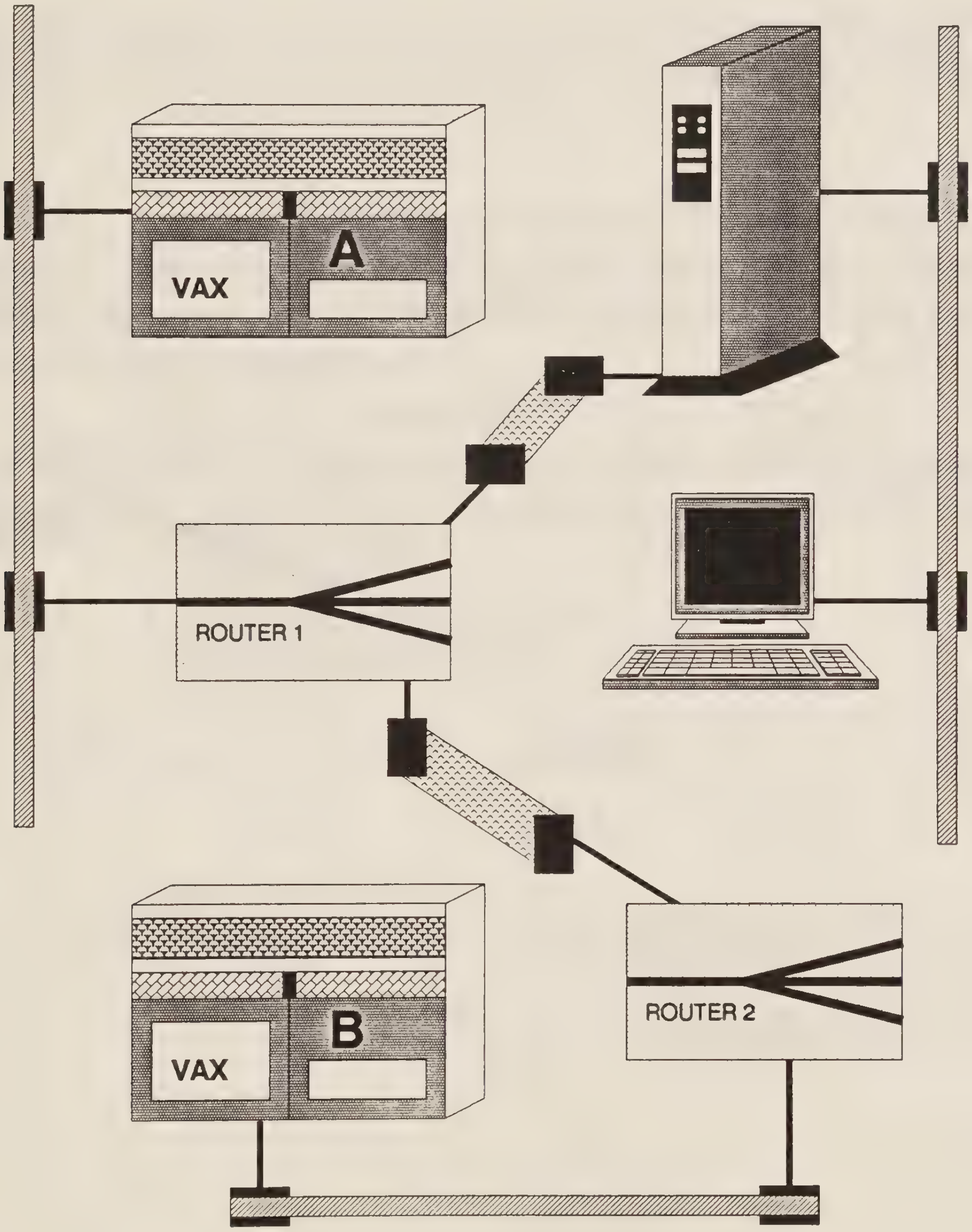
- Routers operate at layer 3 of the DNA model. Thus, routers are PROTOCOL DEPENDENT.

- A router can be either a VAX, which provides routing functionality in addition to other services, or a dedicated Router Server, which only provides the routing service.

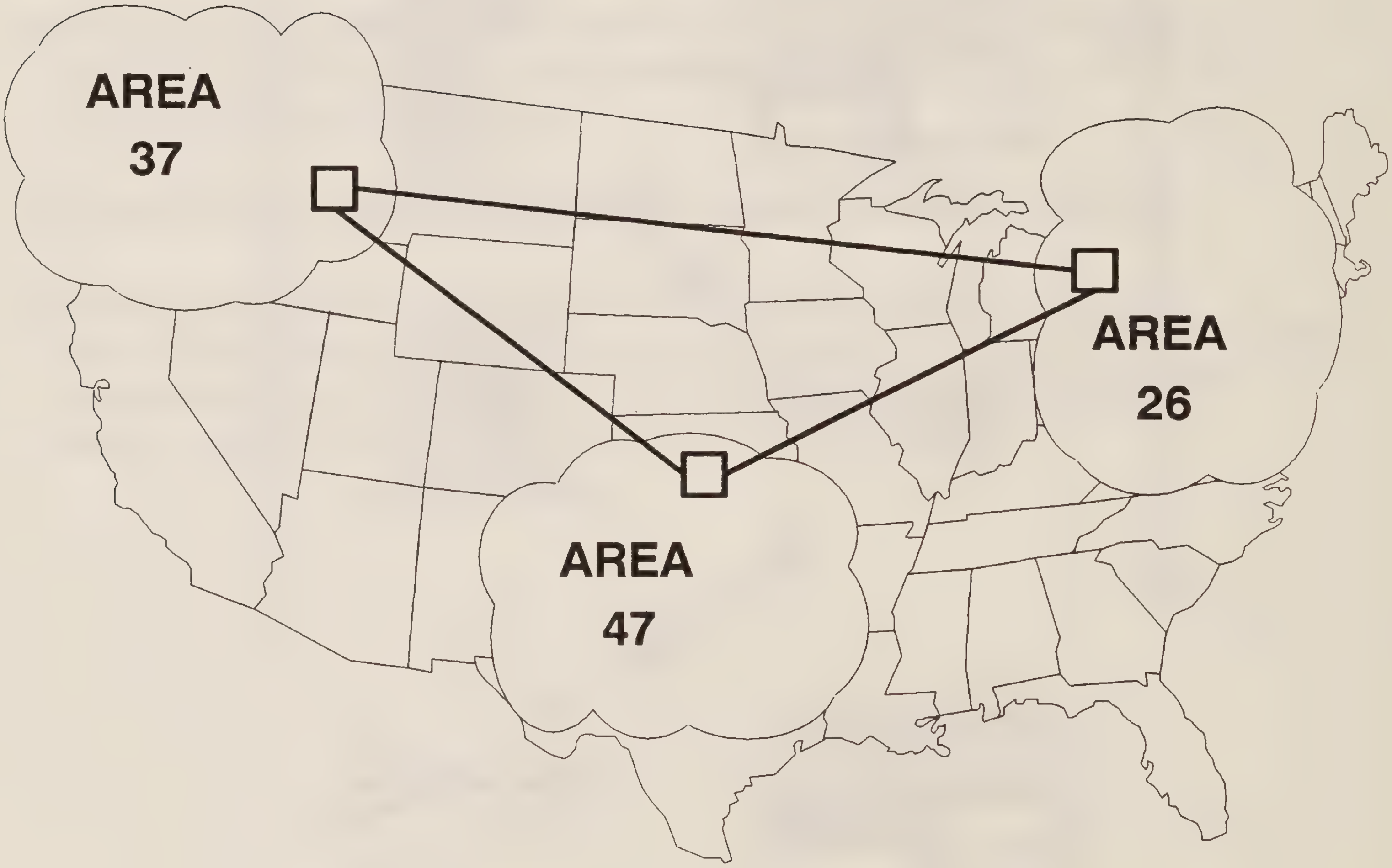
- Routers can be configured as either Level 1 or Level 2 Routers.

- Routers connect to the Ethernet and require a Phase IV host for downline-loading. The Maintenance Operations Protocol (MOP) is used to downline-load the operating of the router. Backup hosts can be designated in case the primary host is out of operation.

Level 1 Routing



Level 2 Routing



Kinds of Routers

- DECrouter 200. Up to 8 local or remote connections. All eight lines can run at 19.2 Kbit/s. Maximum throughput of 170 packets/s. Has a dial-up capability.

- DECrouter 2000. A Level 1 and Level 2 router. Supports DDCMP point-to-point and multipoint links. Handles path splitting. Can have 4 lines at 64 Kbit/s or 2 lines at 128 Kbit/s. Version 1.1 of the router software allows T1 connections.

- Software. Full-function DECnet software allows most DEC computers to function as routers. NOTE: Ultrix nodes cannot yet perform routing functions.

Terminal Servers

- Use to connect terminals, modems, printers, any other device that can behave like a terminal (i.e. a PC running terminal emulation software).
- Multiple sessions can be maintained. Only one is active at any one time.
- Load balancing. Multiple nodes can offer the same service. Terminal servers can be configured to connect to the node that has the best service rating based on current loading.
- Automatic Session Failover. Used in a clustering environment to allow logical connections to servers.
- Multiple levels of security. Passwords can be used to limit access.
- With Polygon Associates Poly-xfr (or other PC communications packages), can do file transfer to PCs. Cheap way to put PCs on line without making them full members of the network.
- DEC terminal servers use the Local Area Transport protocols, not DECnet. This increases performance over the DECnet CTERM protocols by offloading the control function from the host to the server and by multiplexing traffic into Ethernet frames.

Local Area Transport (LAT) Protocol

- This architecture is NOT part of DNA. LAT is an alternative architecture designed specifically for terminals accessing hosts on an Ethernet. DEC Terminal Servers use the LAT protocols.

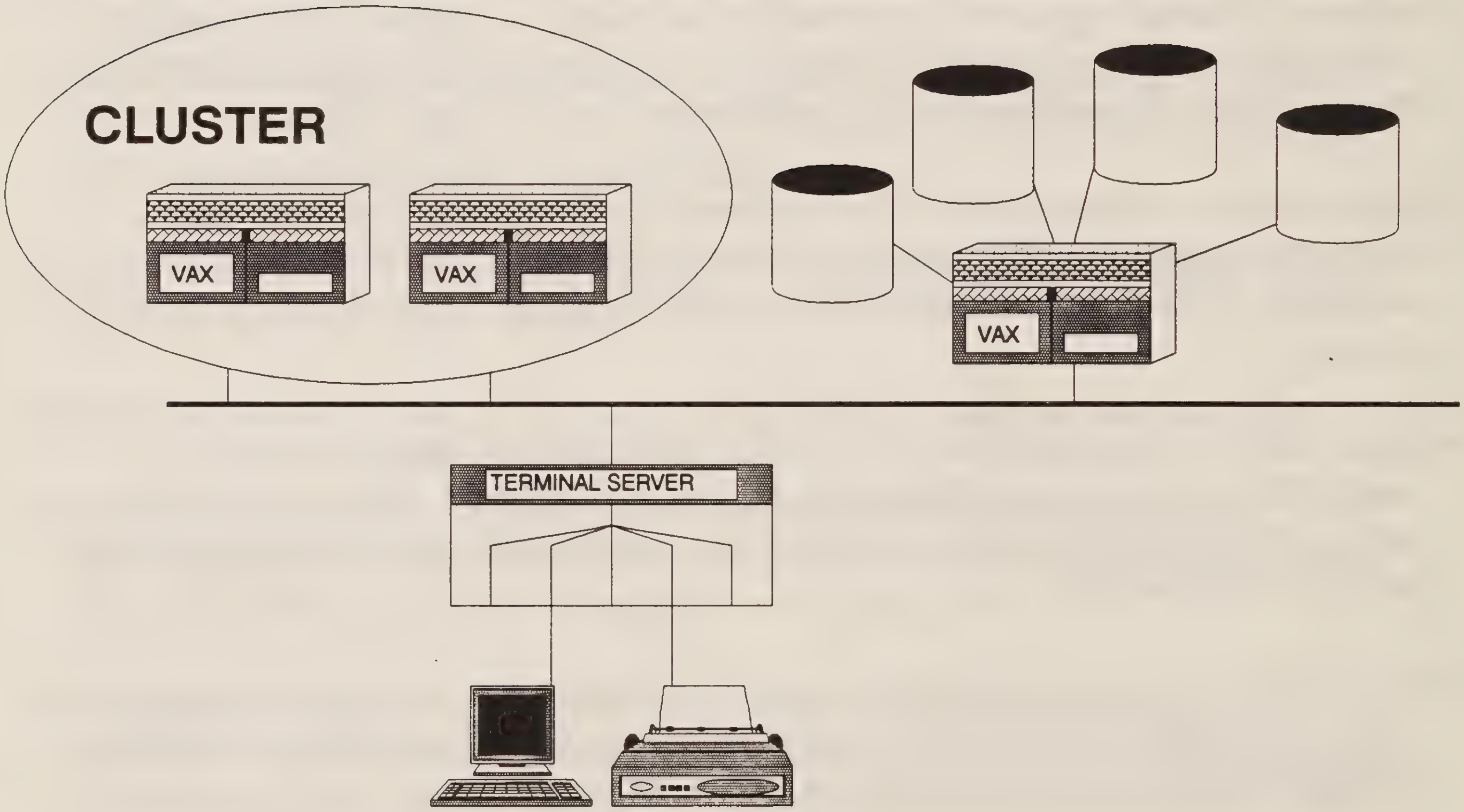
- Instead of sending each character to the host in a separate packet, all data destined for a particular host, regardless of which user, is held for 80 ms. After 80 ms, the data is multiplexed into a single Ethernet packet.

- Because the terminal server is responsible for delivering data to the host, the host does not have to process interrupts for each character received. This offloads some processing from the host to the terminal server.

- Each LAT service provider (i.e. a VAX) periodically advertises the availability of services. Each service has associated with it a service rating. On a VAX, the service rating is a function of login slots available and CPU saturation.

- The LAT terminal server is then able to connect the user to the particular service provider with the best service rating. The usual use of this load balancing feature is in a cluster environment.

LAT Terminal Server

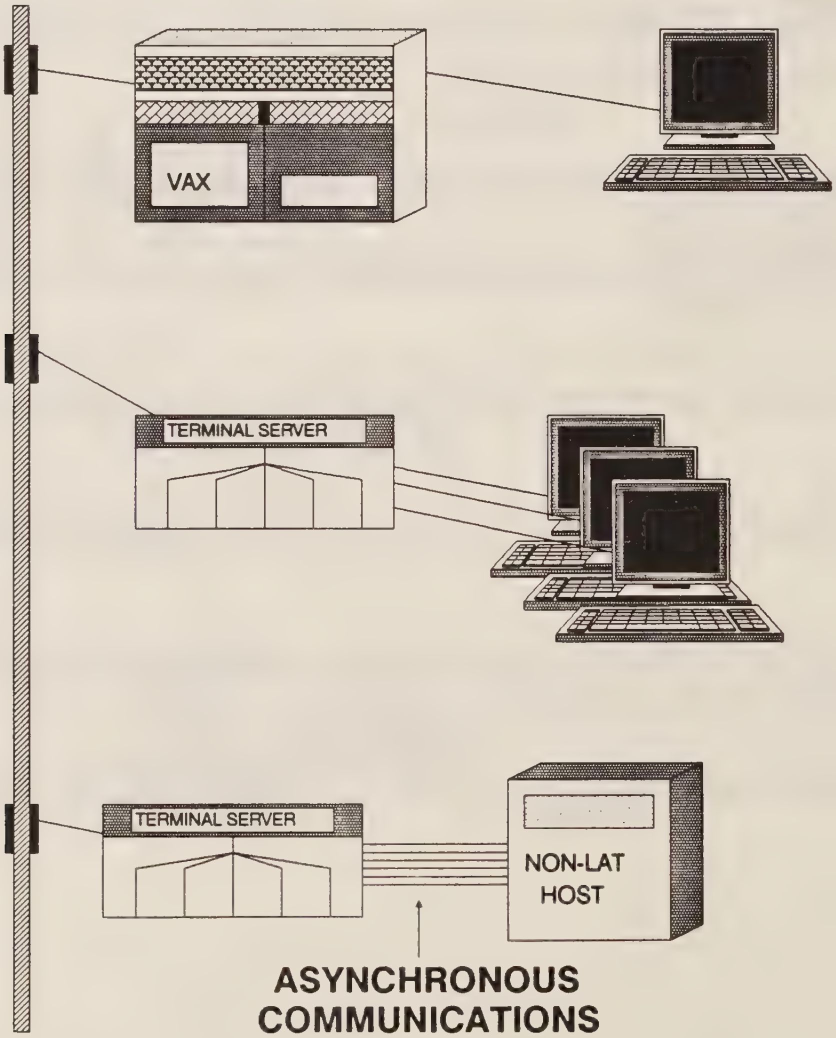


Types of Terminal Servers

- DECserver 200DL supports 8 lines. All lines can be configured at 19.2K bits/s. No modem control.
- DECserver 200MC same as above, but with modem control.
- DECserver 300 has 16 ports. Priced at $4,400, the product is very cost competitive with thrid party offering.
- DECserver 550 supports three types of terminal interface.
    - > A CXY08 board provides 8 EIA-232-D connections with full modem control.
    - > A CXA16 board provides 16 EIA-423-A connections, no modem control.
    - > A CXB16 board provides 16 EIA-422 connections, no modem control.
    - > 3270 Terminal Option Card. Allows an IBM 3270 terminal user access to DECnet networks.
    - > You can mix these boards in any combinations up to 8 maximum.

Reverse LAT Capability

- A Terminal Server can provide a transparent logical terminal connection to a non-LAT host. Any host that supports XON/XOFF, the ASCII standard, and also has EIA-232-D interfaces that can be connected with a Terminal Server.

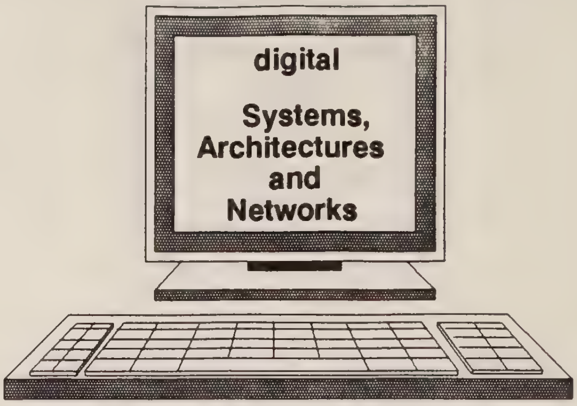


PC Connection Options

- The cheapest solution is to have the PC emulate a terminal. This has less functionality than DECnet, allowing only terminal emulation or file transfer using programs such as Kermit.

- DEC's solution for PC integration is called Personal Computer Systems Architecture (PCSA). PCSA consists of three products.
  - > VAX/VMS Services for MS-DOS. Allows any DECnet VAX to function as a PC server.
  - > DECnet/PCSA Client. PC software to allow it to communicate with the VAX server via an Ethernet DEPCA adapter card.
  - > DECnet-DOS. Allows PCs to be end nodes on a DECnet network. Supports task-to-task communications, remote file access and network resource sharing.

- VAX/VMS Services for MS-DOS provides:
  - > PC Mail. A menu interface to the VMSmail facility.
  - > Support for eight virtual drives.
  - > A menu interface for installation, system and network administration chores.
  - > VT320 terminal emulation and a broadcast capability.



PC LAN Server

- Based on a MicroVAX 2000. Comes with an Ethernet controller, TK50 tape cartridge, 4 MBytes of memory and a 159 MBytes RD54 disk drive. Uses the VMS operating system.

- The PCLAN Server 2000 can work in a PC (only) network, or can integrate into a larger DECnet. Designed to support 8 to 30 client nodes. Uses the VAX/VMS Services software.

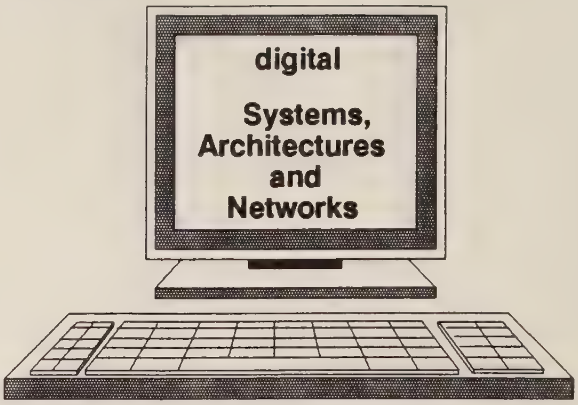
- The PCLAN Server 3100 can support up to 57 client PCs.

- Expect a PCLAN Server 3300 and 3800 soon. These will be based on the coorsponding MicroVAX models. The PCLAN Server 3300 should support up to 90 client PCs. The PCLAN Server 3800 will support over 90 clients.

Ethernet Installation Steps

- Site preparation
- Cable test and installation
- Installation of transceivers
- Installation of network controller
- Diagnostic checkout of installed components
- Installation of communication software
- Configure network database
- Activate network software
- Test network software and hardware
- User training
- Turnover to users

ETHERNET NETWORKS



Key Concepts in This Section

- Ethernets can use a variety of different media. Contiguous Ethernets can use combinations of fiber, twisted pair, COAX, Broadband and ThinWire.

- Extended Ethernets are used to avoid Ethernet saturation, and to get around distance and node limitations.

- Routers offload levels 1 and 2 routing decisions from VAX hosts. They are slower than Bridges but have more functionality.

- Terminal and print servers are ways to offload other support functions from VAX hosts.

Exercise: Facilities Planning

- Corporate headquarters has decided to build a new 21 story building. As Director of MIS, you have the responsibility to plan the corporate information system (CIS). The 10th floor will have a 3600 square foot facility for data processing equipment. Floor one is the lobby and receiving area.

- Floors 2 through 21 will be used by the different departments. A typical floor plan is attached. Each floor has:

  > 20 small offices and 4 large offices

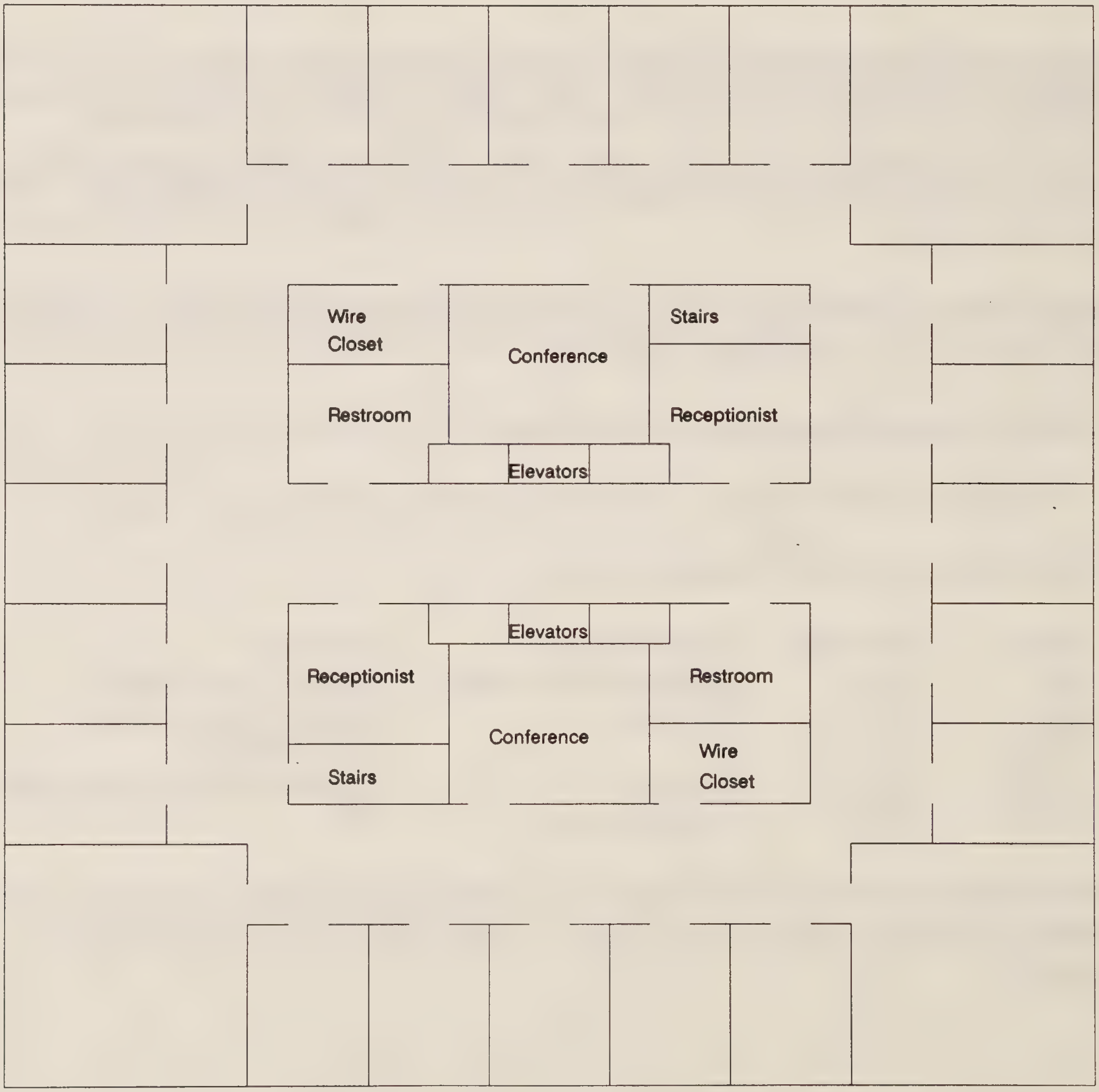
  > A large partition area, 3 closets, elevator, bathrooms, stairs

- The following are floor assignments:

Floor	Number	Department	Function
2-5	200	Customer Service	Field Phone Calls
5-9	200	Finance	Collect Money Due
10-12	150	DP	Your People
13-15	150	Admin	Personnel, Building, Etc.
16-21	300	Management	???

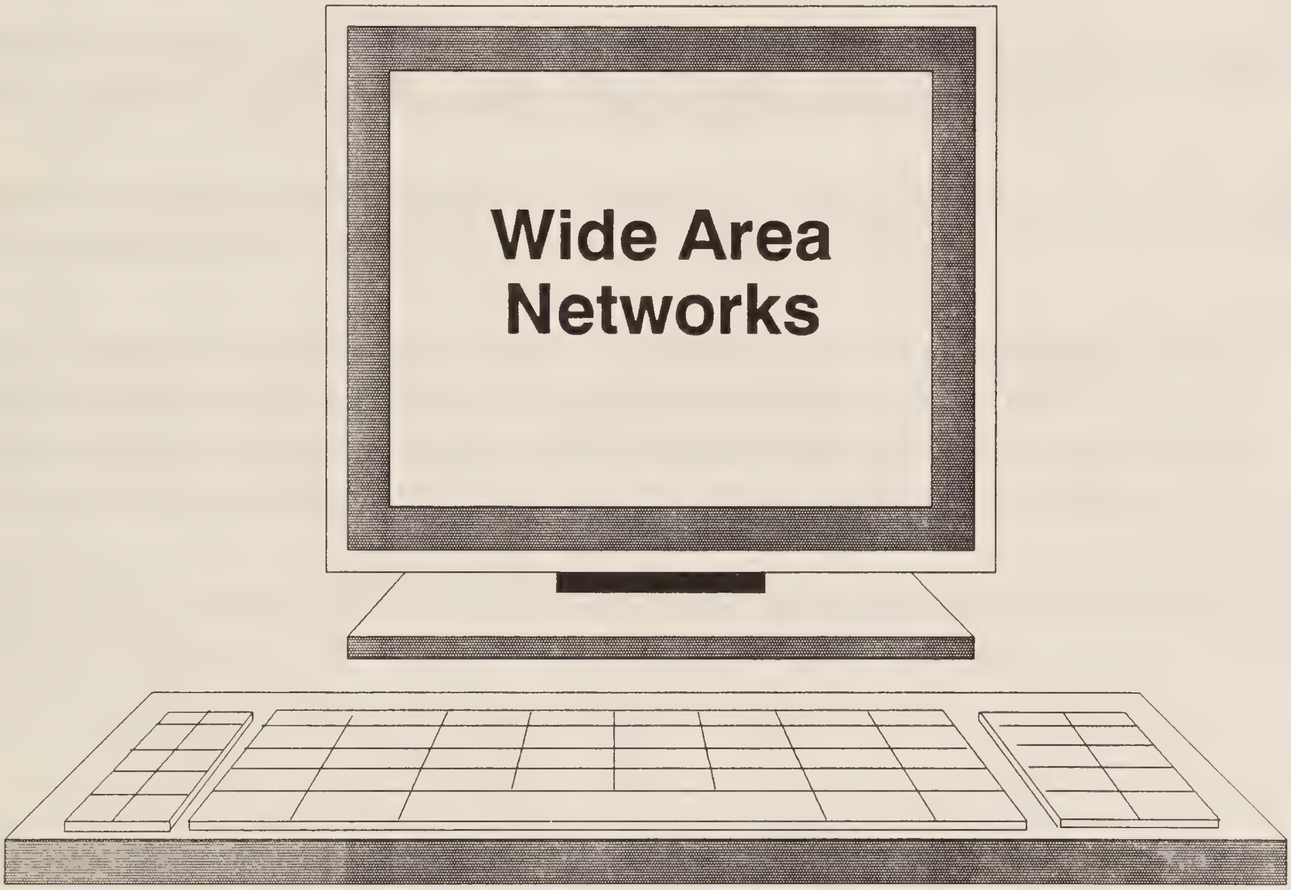
- The President of the corporation has asked you to design a typical floor cabling plant and develop the cabling strategies the company should pursue.

Floor Plan

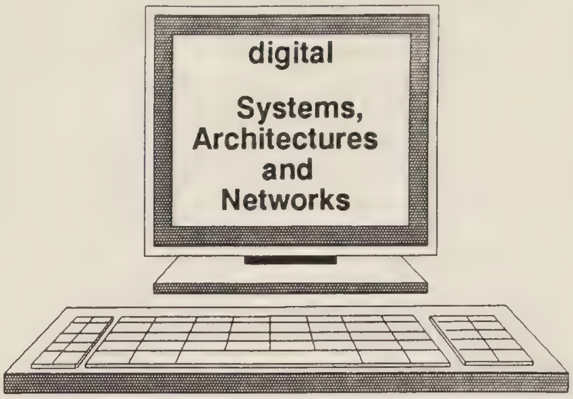

Wire Closet
Conference
Stairs
Restroom
Receptionist
Elevators
Elevators
Receptionist
Restroom
Conference
Wire Closet
Stairs

"But what is free enterprise really about? Competition. And competition was something the loan guarantees stood to provide a lot more of. Why? Because they would guarantee that Chrysler would still be around to compete with GM and Ford."

Lee Iacocca


Wide Area
Networks

WIDE AREA NETWORKS



Overview

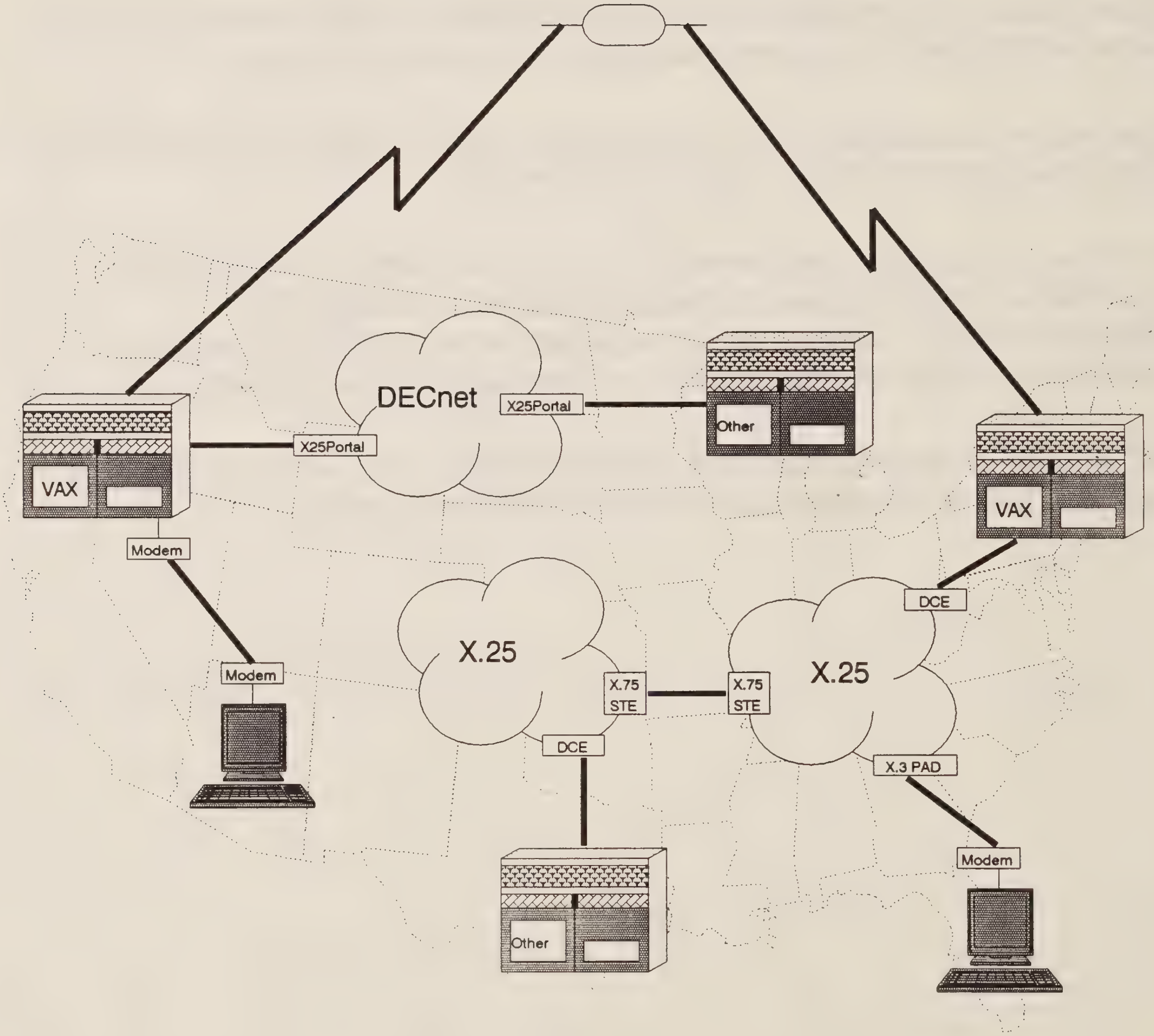
- Wide Area links are used for a variety of different applications ranging from remote terminal access to linking Ethernets together.

- The two most common ways to provide a remote connection is through a dedicated DDCMP link or via an X.25 network.

- X.25 networks allow permanent and switched virtual circuits to be established that are used to transmit packets of data. This packet-switched network provides adaptive routing and sharing of bandwidth and switching equipment across multiple systems.

- ISDN is an emerging standard for digital wide area networks that will carry all forms of information including data and voice.

Wide Area Networks



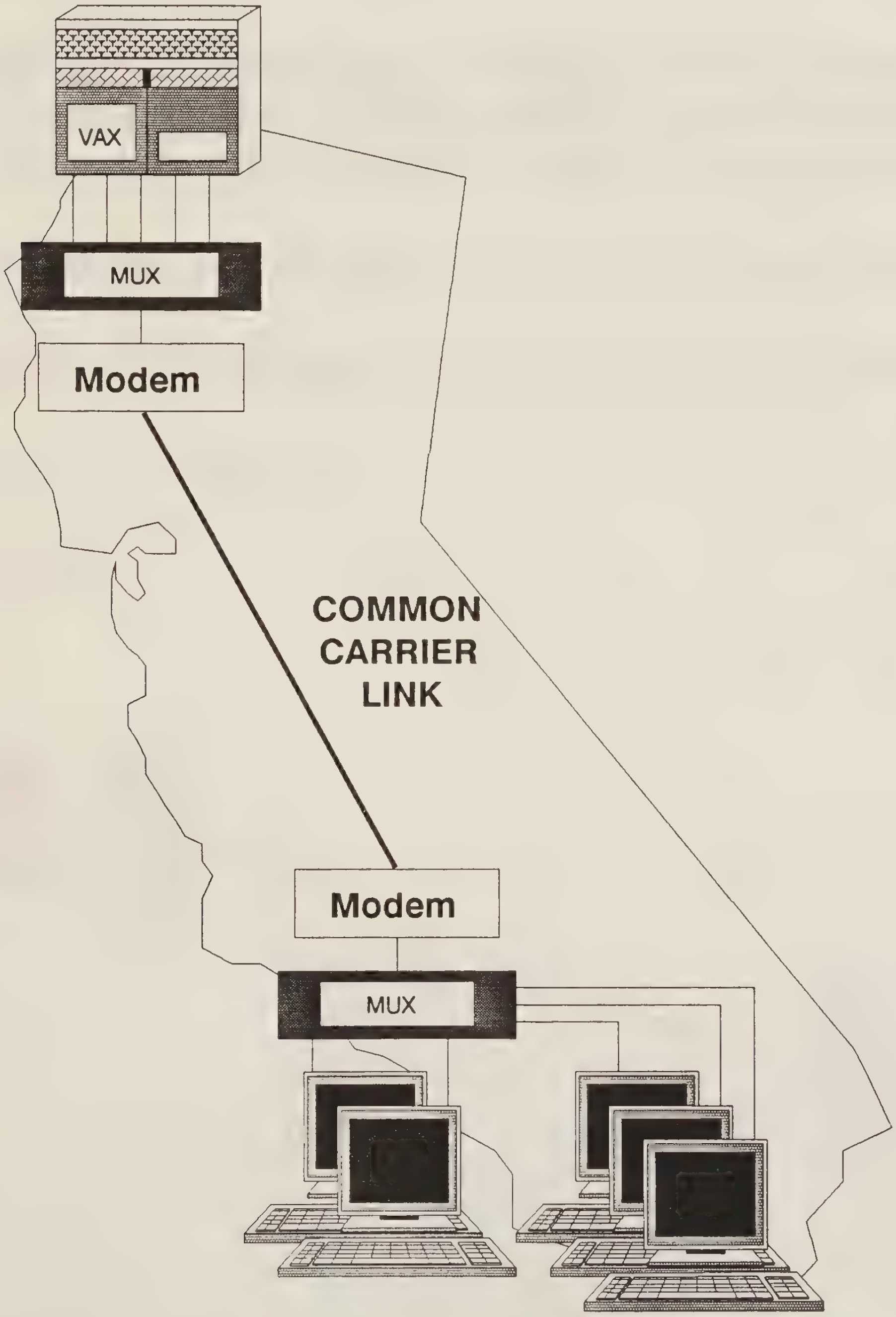
Wide Area Links

- Several of the packet-switched networks (PSN) allow value added networks to be built on top of their existing system.
- Microwave links are feasible if you have an uninterrupted path.
- Satellite links are another method of providing point to point connections.
- High capacity bandwidth is dropping dramatically in price. T1 (1.544 Mbps) and T3 lines (28 T1 lines) are becoming readily available. A draft CCITT and ANSI standard is the Synchronous Optical Network (SONET) standard which provides for bandwidth in multiples of 51 T1 lines up to a bandwidth of 2.488 Gbps.
- The TransLAN Bridge could be used to connect long haul T1 lines (See WAN in Ethernet Section).
- DEC has a marketing agreement with StratCom, Inc. to sell the StratCom IPX T1 multiplexer. The IPX multiplexer allocates bandwidth on an as needed basis. Most T1 vendors assign bandwidth for point-to-point connections. StratCom's fast-packet approach should increase transmission efficiency. The top of the line IPX 32 supports up to 16 T1 trucks. It can be configured for 192 voice and 100 data connections.

Modems and Multiplexors

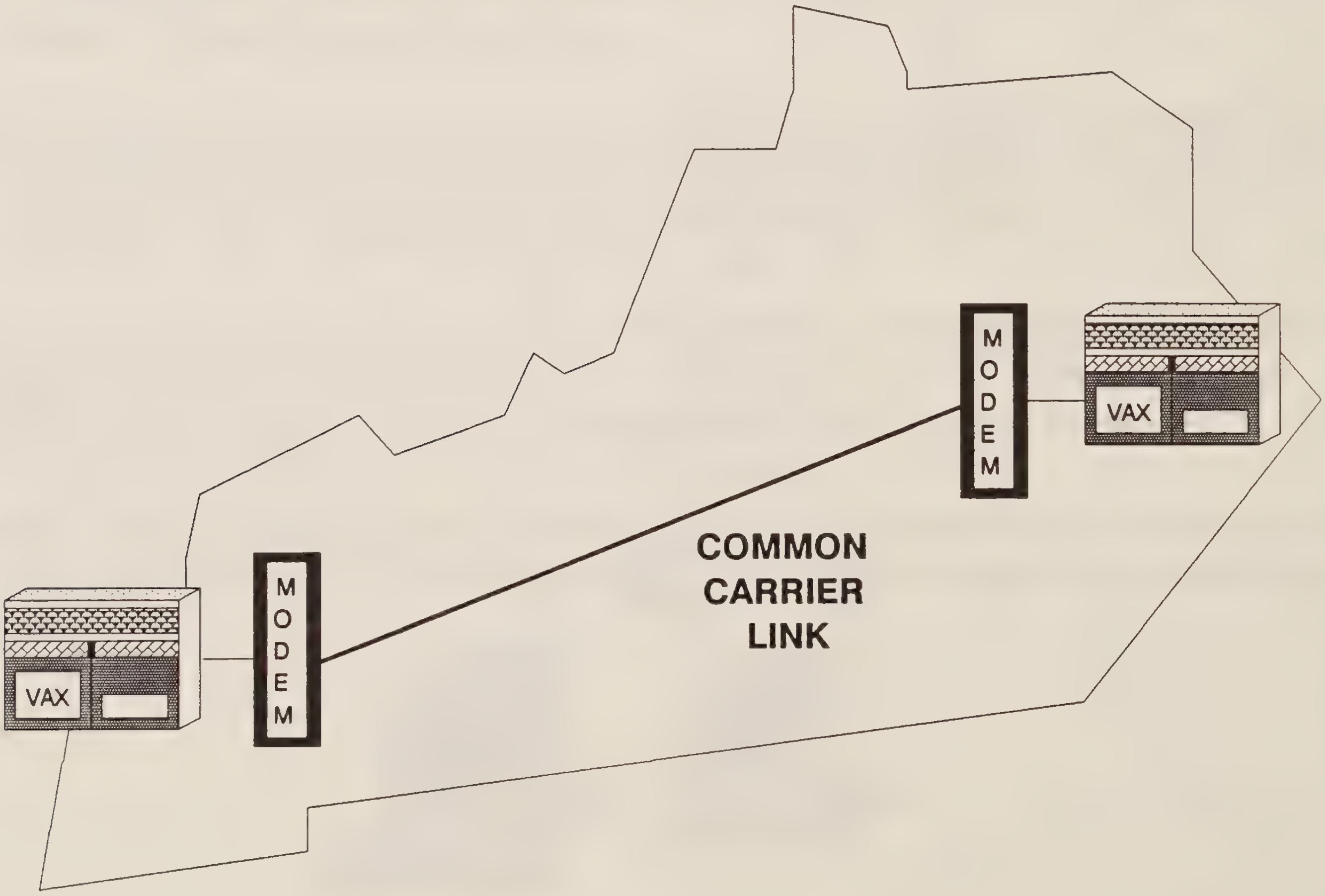
- Most modems can be rack-mounted, saving considerable space in a machine-room environment.
- Multiplexors often have integral (built-in) modems.
- Communications standards are fairly well defined for 300 to 2400 bits/s systems. If your system has dial-in service from unknown systems, look for modems with autobaud capabilities so you don't need a different number for each type of modem.
- CCITT V.27 and V.29 are rapidly becoming the standard for 4800 and 9600 bps modems. Many modems can operate over non-leased lines and adjust their transmission speed when line conditions vary.
- Many vendors carry modems or other access devices for leased line applications with speeds of 19.2 to 56 Kbps up to T1 speeds (1.544 Mbps). Note that T1 lines are digital and do not use a modem.
- DEC sells the MUXserver 300 and DECmux 300 Remote Terminal Server. Used together, you can connect up to 48 remote users to a local Ethernet LAN.

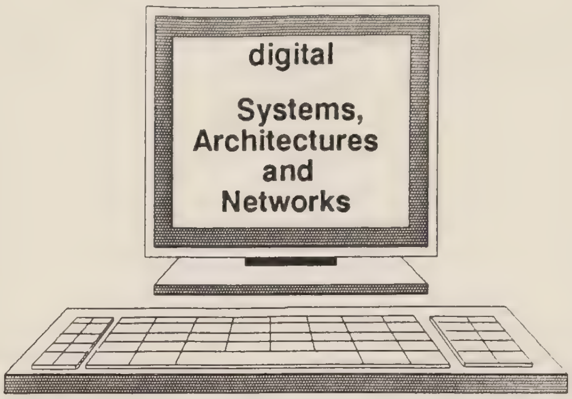
Remote Terminals



Point To Point Synchronous Links

- Remote DECnets often use a point to point link, using the DDCMP data link protocols. DDCMP can connect various combinations of routers, VAXes or other general purpose computers.
- Dial-up lines will now support speeds of up to 19.2 Kbps.
- Dedicated lines can provide 9.6 to 19.2 Kbps. 56 to 64 Kbps and T1 connections.





Possible Users of Wide Area Links

- Remote Terminals or PCs
- Dedicated Routers - Asynchronous
- Dedicated Routers - Synchronous
- VAX or Host
- Terminal Server with Modems
- Wide Area Bridge

X.25 Protocols

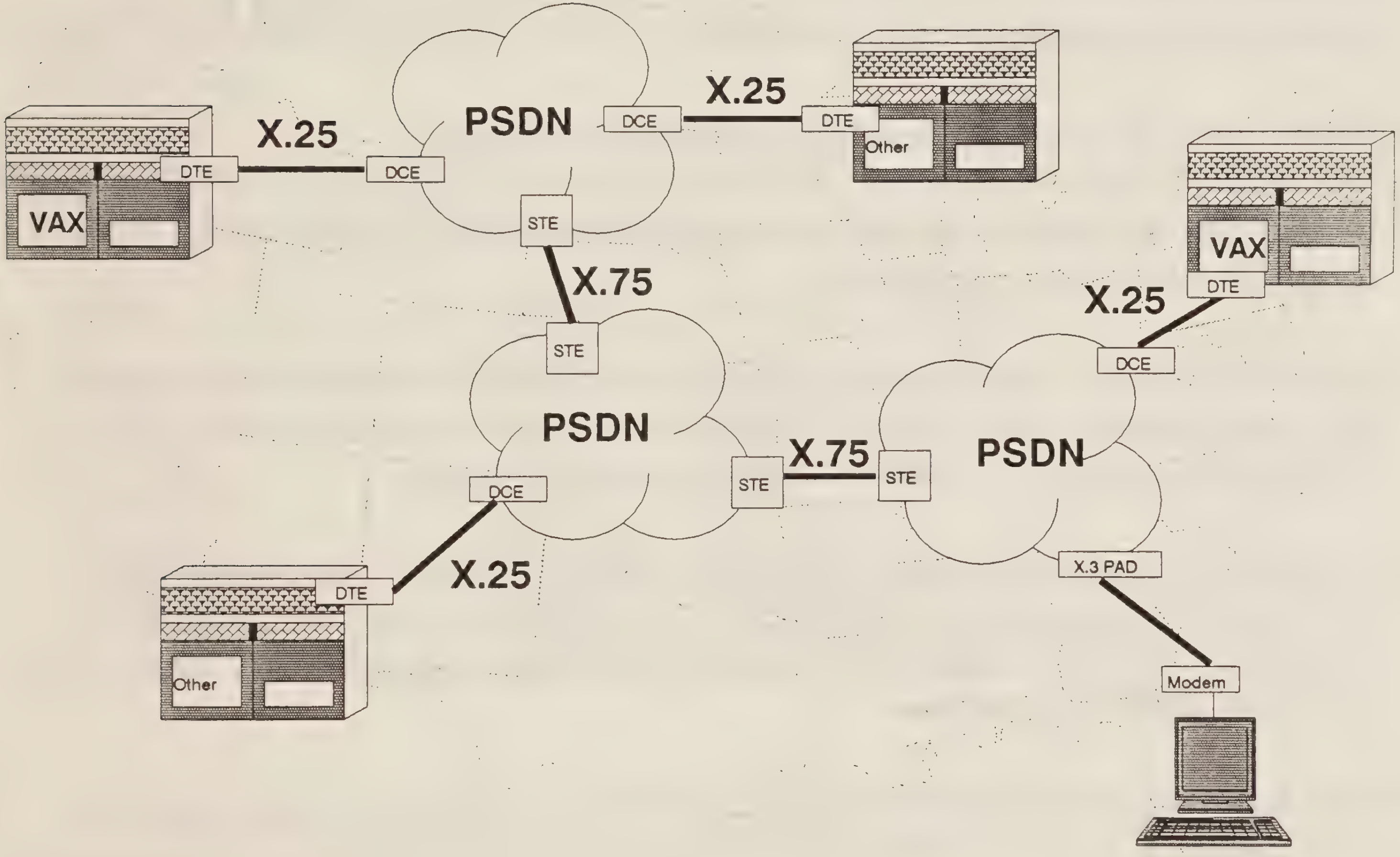
- X.25 is really a catch-phrase for a set of protocols that define the interface to a wide-area packet-switched network. X.25 can be contrasted to a local area network like Ethernet.

- An architecture based on links between Data Terminal Equipment (DTE) and Data Communications Equipment (DCE). A DCE is the link to the network. The DTE is the link to the user.

- Site Termination Equipment (STE) and the X.75 protocols allow different management domains to be interconnected.

- Terminals need an X.3 Packet Assembler/Disassembler (PAD) to convert asynchronous terminal traffic into packets.

X.25 Networks



X.25 and DECnet

?

- X.25 is highly integrated into the Digital Network Architecture. X.25 can be used as an alternative to DDCMP for long-haul connections in a DECnet environment. They can also be used to interface with public or private packet-switched networks to provide interconnection to other non-DECnet systems.

- Virtual circuits are a logical link between two DTEs.

- Virtual circuits can be either permanent or switched. Switched circuits require a call setup procedure.

- To use X.25 as a data link for a DNA system, the line must be initialized as a permanent virtual circuit. This is then made available to the DNA routing layer as a line with a certain number of hops.

- In the DNA implementation, when you call a DTE, you specify a called DTE subaddress, telling the remote DCE which remote DTE module to route the call to. An example would be initiating a remote FAL listener for a remote RMS file access.

- X.25 Gateways can also provide native X.25 access to a heterogenous environment. This provides remote terminal capabilities over the network.

Using a VAX as an X.25 Gateway

- Allows direct access from a VAX to a PSN. VAX PSI (Packet Switch Interface) is on the VAX X.25 Server acting as the access point to the network.
- PSI Access allows DECnet client nodes to use the services of the VAX X.25 Server.
- Many synchronous boards support the LAP B protocols specified for use at level 2 of the CCITT X.25 protocols.

BUS	BOARD	SPEED	LINES
Q-BUS	KMV1A	64 Kbps	1
Q-BUS	DPV11	56 Kbps	1
BI BUS	DMB32	64 Kbps	1
UNIBUS	DMF32	19.2 Kbps	1
UNIBUS	KMS1P	64 Kbps	1
UNIBUS	KMS11	19.2 Kbps	8

X25Portal 2000

- The X25Portal 2000 provides the ability to implement an X.25 based service on top of a DECnet backbone network. This product can make your DECnet network look like a Packet Switched Data Network (PSDN). Any host that can talk X.25 can now use the DECnet network to communicate with any other X.25 host.

- The X25Portal 2000 is a MicroVAX based product that required a load host. Maintains up to 128 virtual circuits.

Remote Terminal Applications

- Most public packet-switched networks will supply an Asynchronous X.3 PAD (Packet Assembler/Disassembler) and a Host Interface to allow terminals to access hosts via their network.

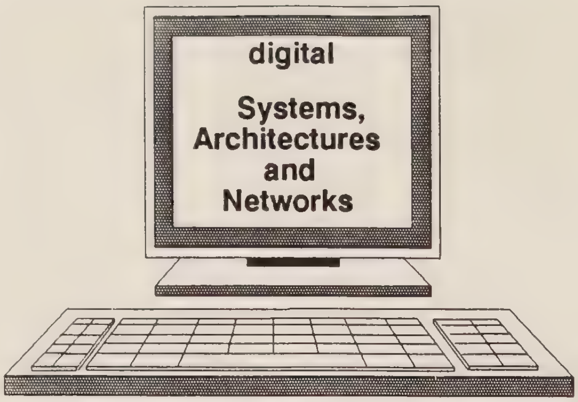
- A PAD is very similar to a multiplexor. A PAD assembles several characters from an asynchronous terminal into a packet. It then disassembles incoming packets for display on the terminal.

- A PAD can be either purchased or furnished by the provider of the X.25 network. Rather than using a dedicated PAD, you can have your terminals dial in to public access points. This limits line speeds to 1200 bps (or possibly 2400 bps in a few locations).

- DEC sells a DFM PAD which can provide access to Public and Private Packet Data Networks. The PAD can be connected to the network access point with line speeds ranging from 2400 bps to 64 Kbps.

- The DFM PAD has been certified by Tymnet and Telenet in the U.S. and DATAPAC in Canada.

- The device can handle up to 16 asynchronous channels.



ISDN

- The Integrated Services Digital Network (ISDN) is an emerging standard for access to wide area facilities. ISDN has many similarities to X.25, and uses a superset of the LAP B data link protocols, the LAP D protocol.

- Primary goal is the integration of voice and non-voice services.

- ISDN allows the allocation of bandwidth over basic data channels (B channels) in increments of 64 Kbps. A D channel is provided for out-of-band signaling. A Basic Rate Interface is composed of 2 B + 1 D channels. The Primary Rate Interface has 23 B + 1 D channel, which is equivalent to a T1 line.

- The LAP D protocols, used on the D channel, allow multiplexing of X.25 packets as well as a variety of control and signalling information.

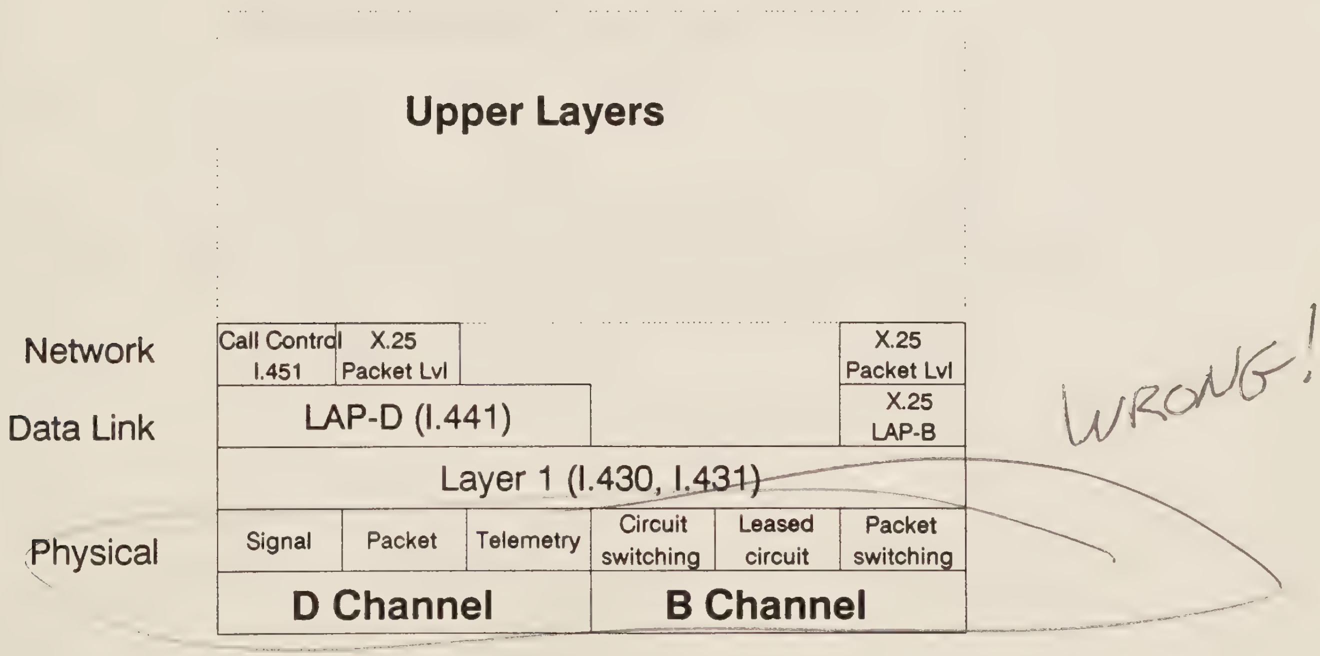
- The B channels will provide transparent bandwidth which will carry different types of traffic including voice, video and various data link protocols.

ISDN Protocols

- ISDN is essentially unconcerned with ISO Layers 4 through 7. These layers are used for end-to-end user communications. The D Channel and B Channel are multiplexed over the same physical connection.

- D Channel is used to establish a circuit between two ISDN users and control signaling. The X.25 protocols can be used to transmit X.25 packets in LAP-D frames.

- B Channel is used for data transfer between two users. ISO Layers 2-7 are transparent. Thus, the vendors are free to use their own protocols, formats and synchronization techniques.



WRONG!

[ISDN]

Key Concepts in This Section

- X.25 can be used within a DECnet environment or as a method to get out to heterogenous environments.
- X.25 on DEC computers is available on general purpose computers via VMS/PSI or on a dedicated gateway.
- An alternative to X.25 is the use of point to point connections and DDCMP.

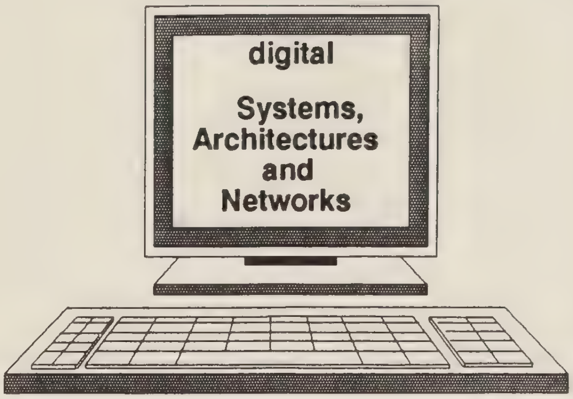
Diversify? No way, says McDonald's chairman, Fred Turner. "We have sixteen thousand rest rooms, " he states. "As soon as those are all clean, we'll talk diversification."

Workman Publishing - New York

WIDE AREA NETWORKS

Digital Software Products

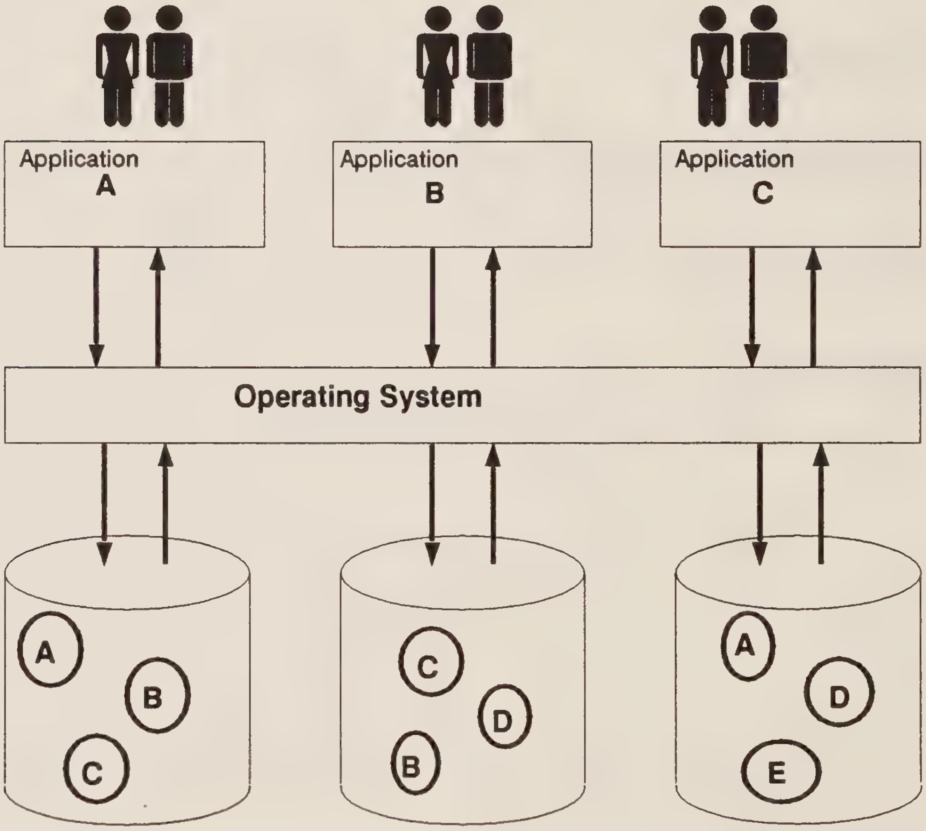
DIGITAL SOFTWARE PRODUCTS



Overview

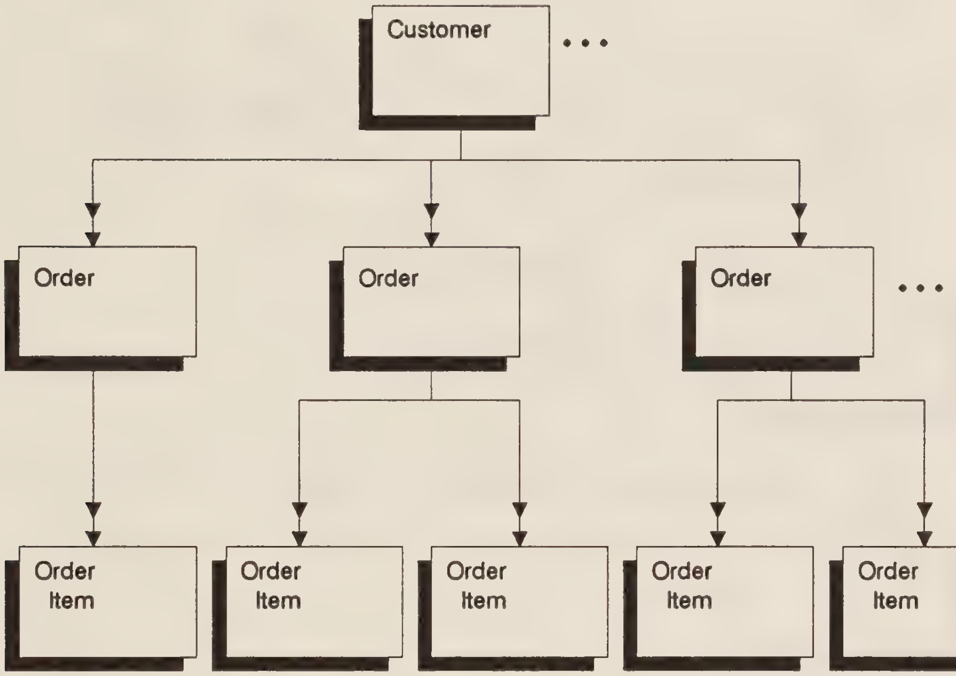
- Data Management Concepts
- DEC DBMS Products
- Distributed Database Concepts
- Communication Products
- Document Production

Pre-DBMS Data Management



- Redundant Data
- Multiple User Environments
- Varying Quality of Implementation

Hierarchical Databases

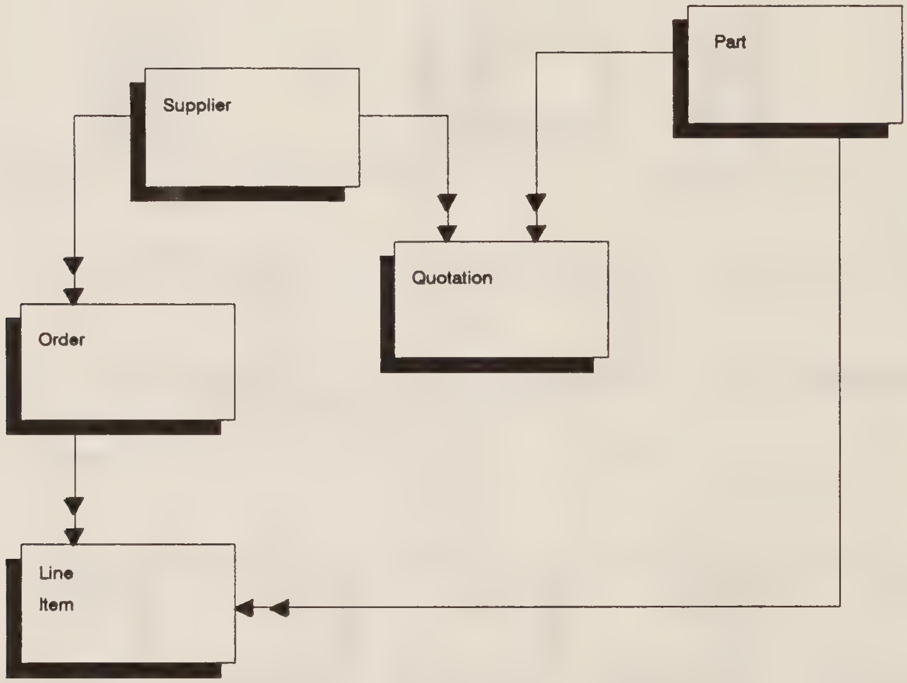


- **Example : IMS. A typical application would be a claims processing system for an insurance company.**

- **Programmer Navigates Structure.**

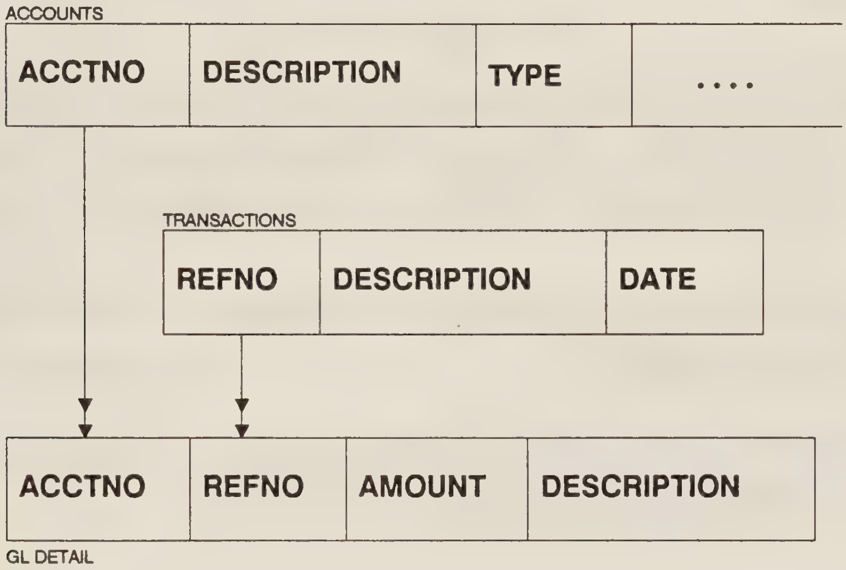
- **Optimal for one access path, but highly inflexible for alternate access paths. Example: "Which customers purchased item #10305?" requires a scan of entire database.**

Network (CODASYL) Databases



- **Example: VAX DBMS**
- **Alternate access paths but inflexible for changes in user requirements. Example: Adding salary information would require rebuilding and redesigning the database.**
- **User interfaces usually limited to Cobol-based development environments.**

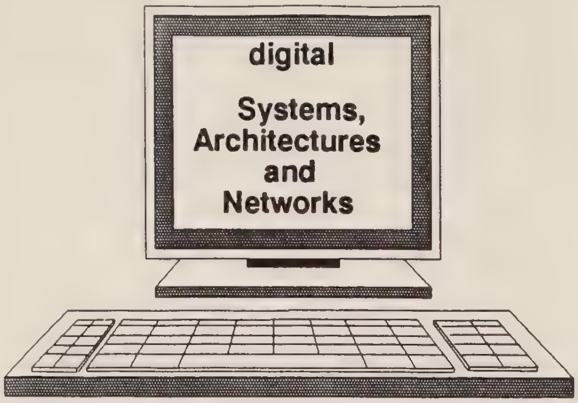
Relational Databases



- **Examples: DB2, Ingres, Interbase, Oracle, Rdb, Sybase, Unify. Newer generation of technology with more sophisticated user interfaces. More flexible for ad hoc applications.**

- **Data arranged in tables. This separates the physical from the logical structure of the data. Data is retrieved in sets, sparing the programmer from navigating the database.**

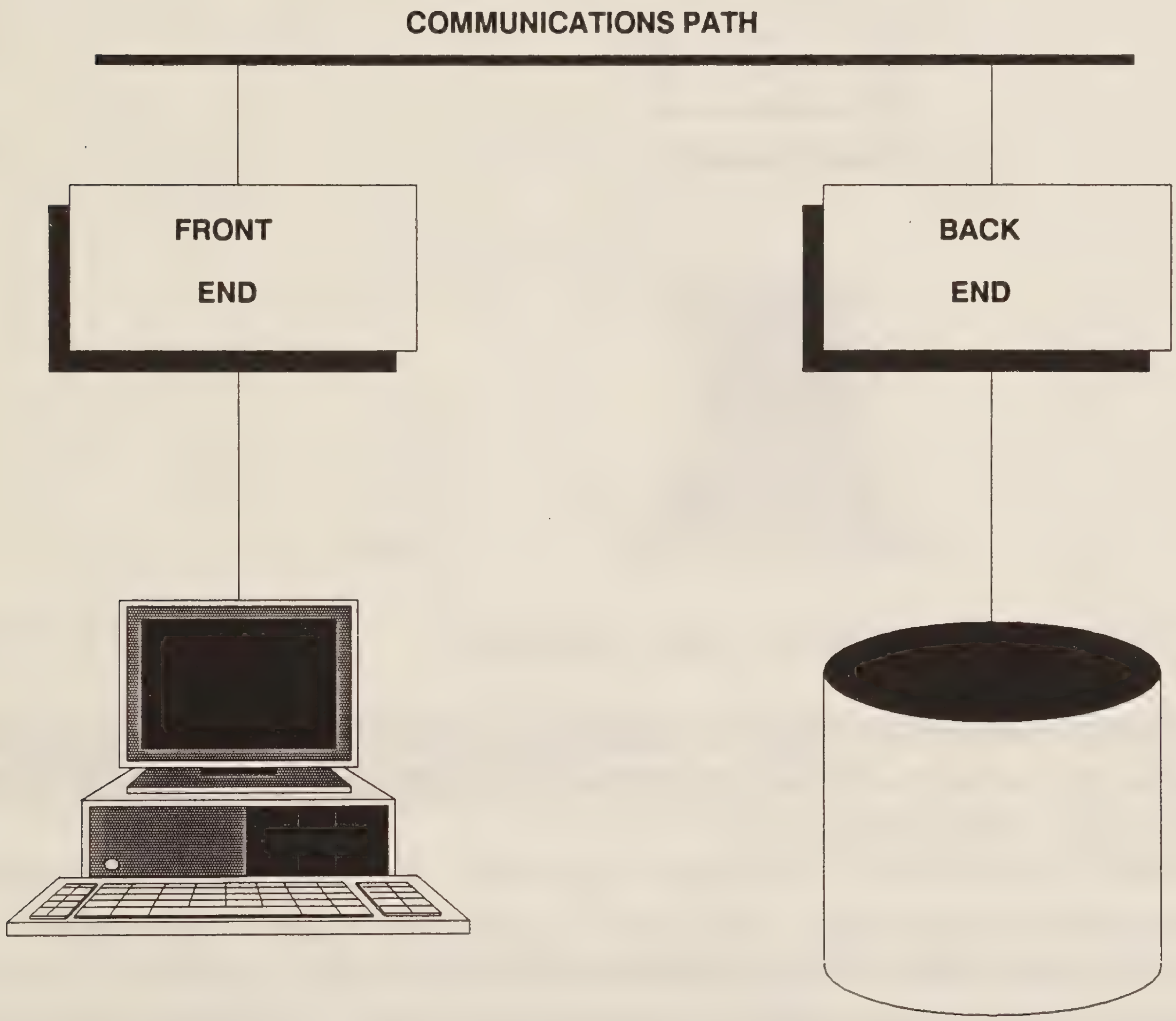
- **Beginning to be a serious player in performance related applications like transactions processing.**



Front v. Back-End Functions

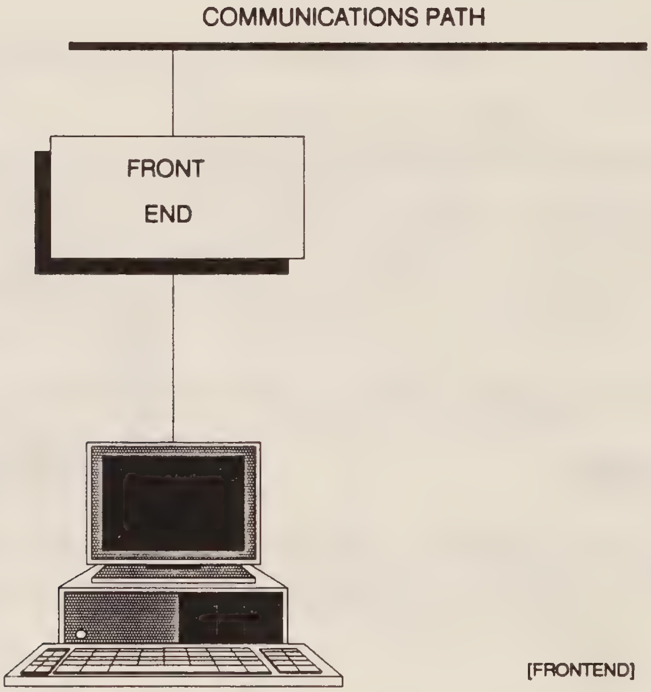
- Separation of user interface from data access routines. Each one is a different program.
- Both programs can be in one computer and communicate via main memory. Or, the programs can be on different computers and use the interprocess communication facilities of the network to communicate.
- This architecture is present in almost all relational DBMS systems that work in the DEC environment.
- Leads to flexibility in distribution of data, design of applications, and configuring and optimizing a distributed network.

RDBMS Front-End and Back-End Processes



[RDBMSFUN]

Front-End Functions

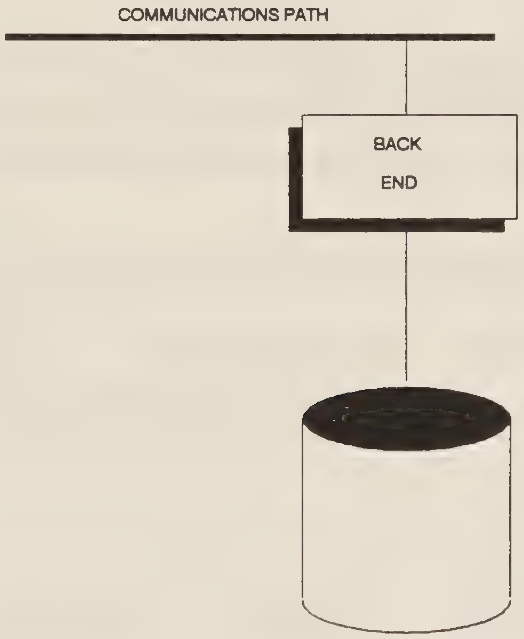


- Presenting and managing the user interface.

- Presents the user with a high level language which is then transmitted to the back-end. A forms-based interface would translate the user's choice of fields into a SQL statement.

- 4th Generation Languages (4GL) and Application Generators allow a high level specification of application systems. Many times, the definitions of the forms, menus, reports and other portions of an application are stored in the back-end in a compiled form to allow security over these objects and higher performance at run time.

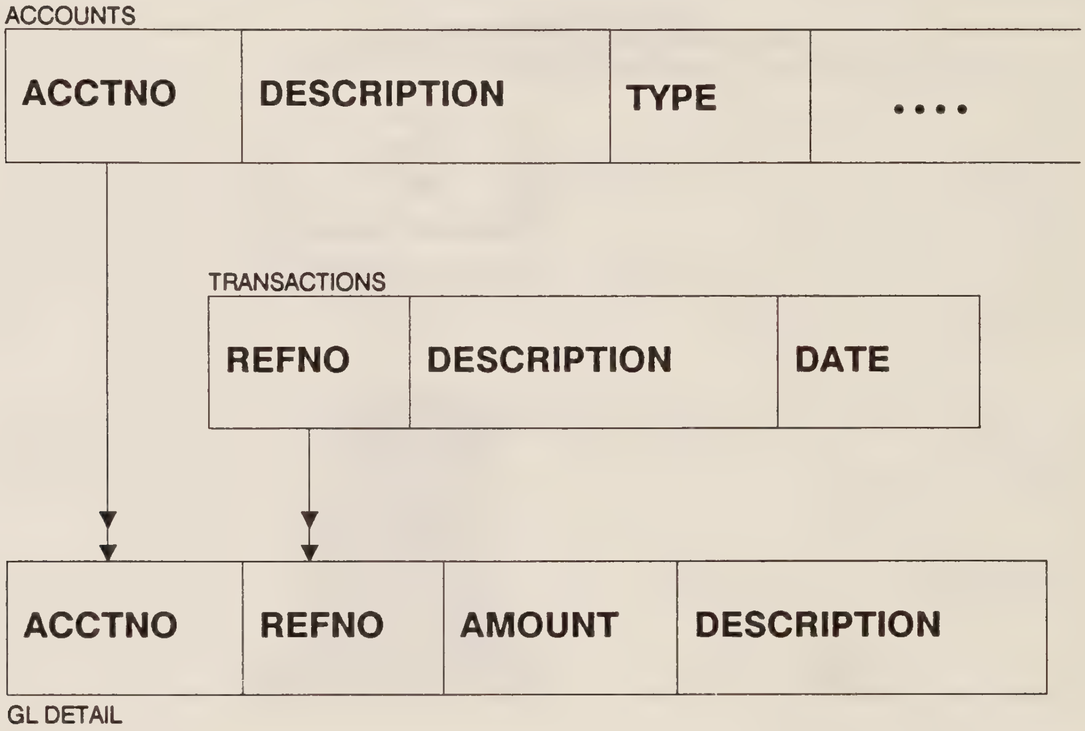
Back-End Functions



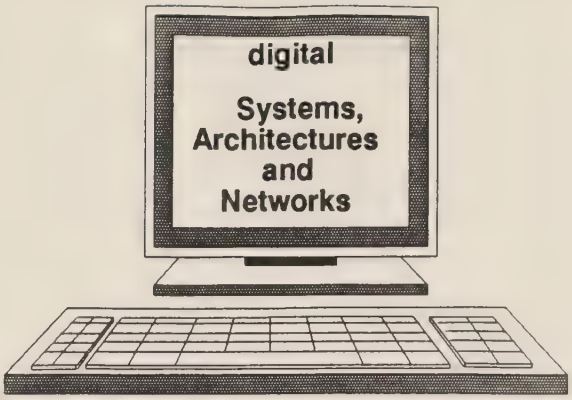
[BACKEND]

- **Query optimization.**
- **Concurrency. Coordination of locking so multiple people can access the same data and the database still stays consistent.**
- **Journaling and Recovery. Keeping track of the changes in a database.**
- **Implementation of security and performance features. Allows the security environment and the definition of indices to change dynamically and be enforced uniformly.**

Referential Integrity



- Prevents unreachable records.
- Triggers allow update and delete operations to be cascaded through the database.
- Rather than use a before image journal, Interbase has a multi-generational storage scheme which keeps both records in the system. It is the responsibility of subsequent operations to delete "uninteresting" generations of the data.



VAX Information Architecture

- The VAX Information Architecture is a set of products that can function independently or as an integrated whole. You can think of the VIA as a tool chest with tools of different complexity and power.

- There are many software products that make up the VIA. Some of the more common ones are:

  > VAX Common Data Dictionary.

  > VAX ACMS.

  > VAX TDMS.

  > VAX TEAMDATA.

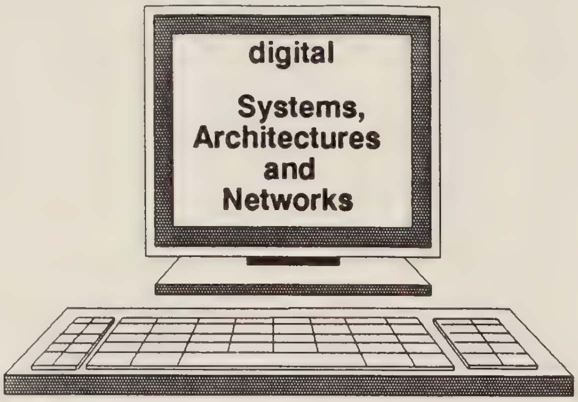
  > VAX DATATRIEVE.

  > VAX FMS.

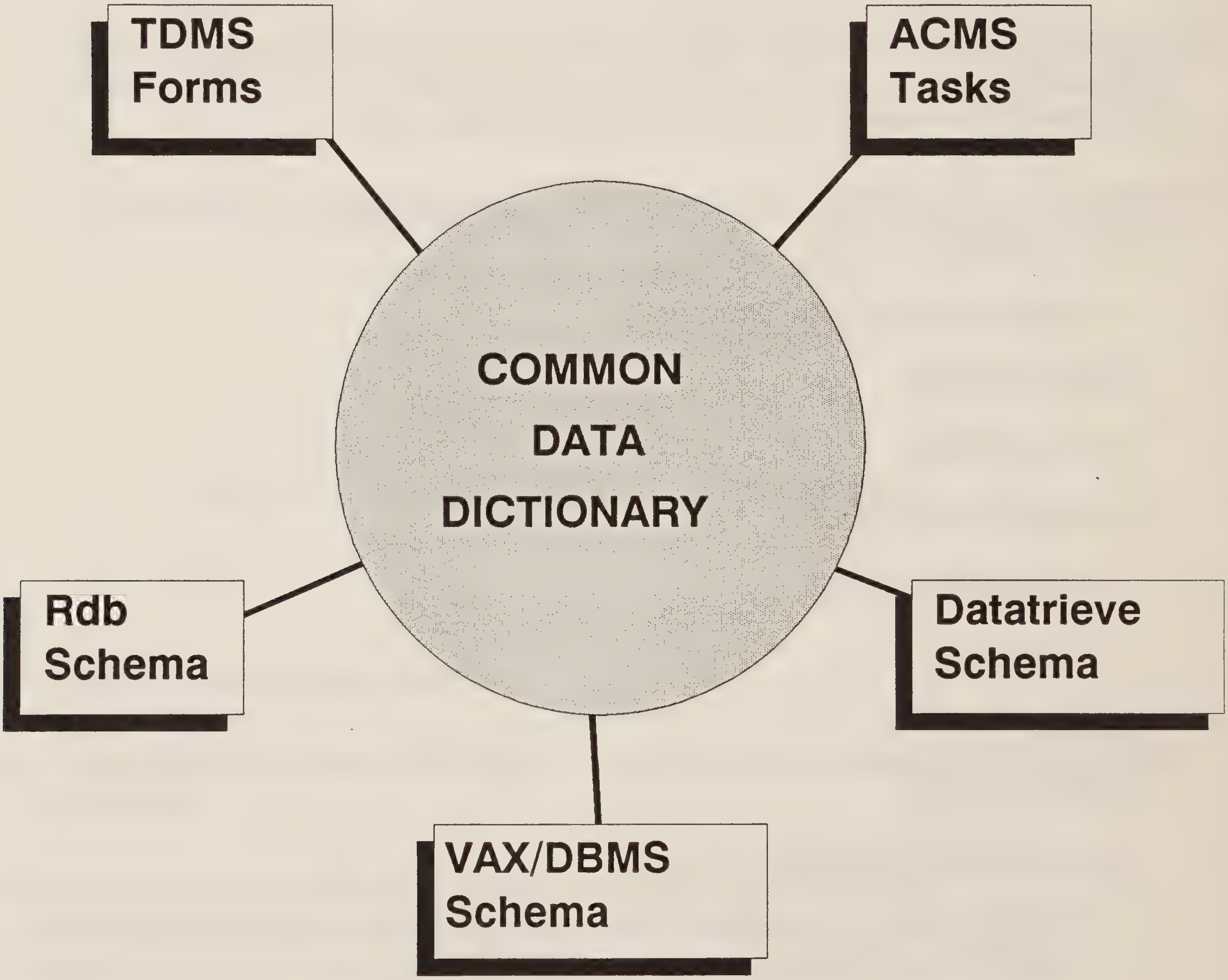
  > VAX Rdb.

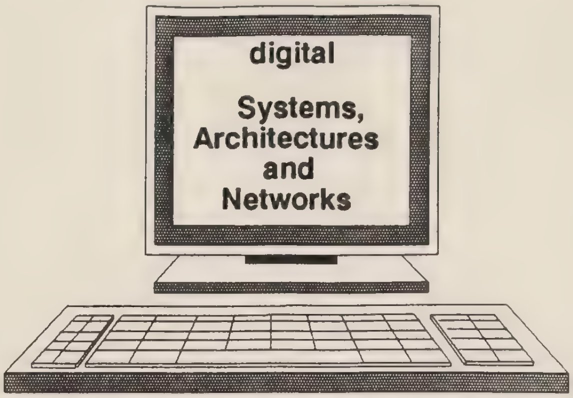
  > VAX DBMS.

  > VAX Cobol Generator V1.3.

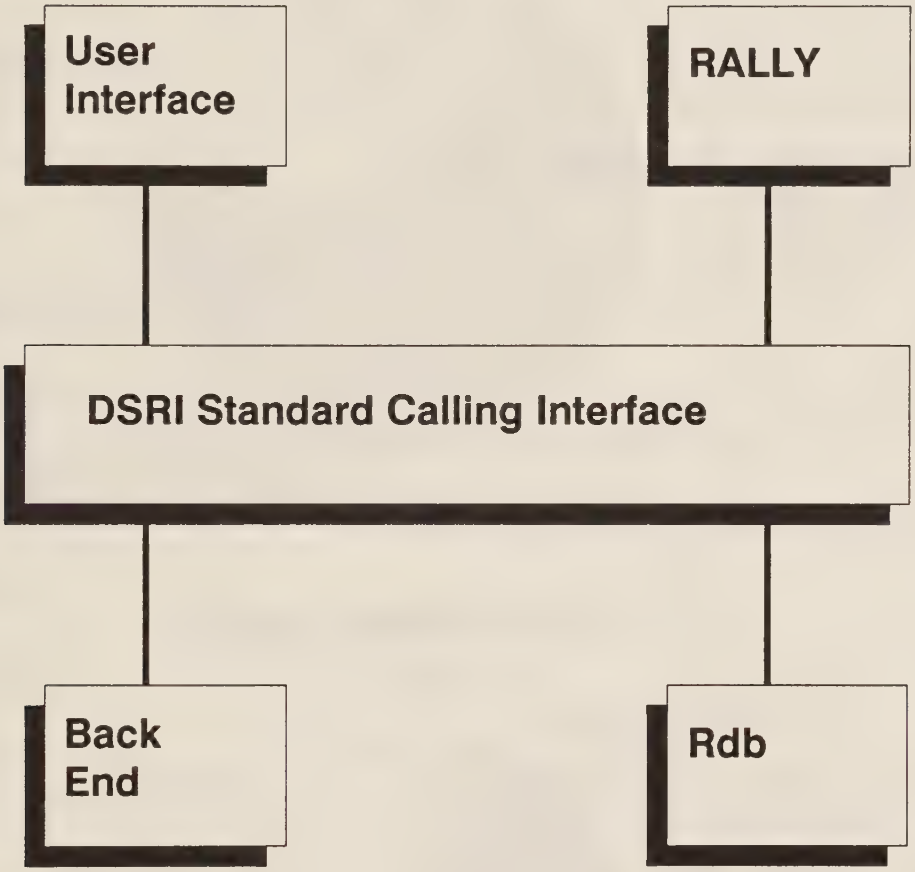


VAX Information Architecture Implementation





Digital's Standard Relational Interface (DSRI)



User Interface

RALLY

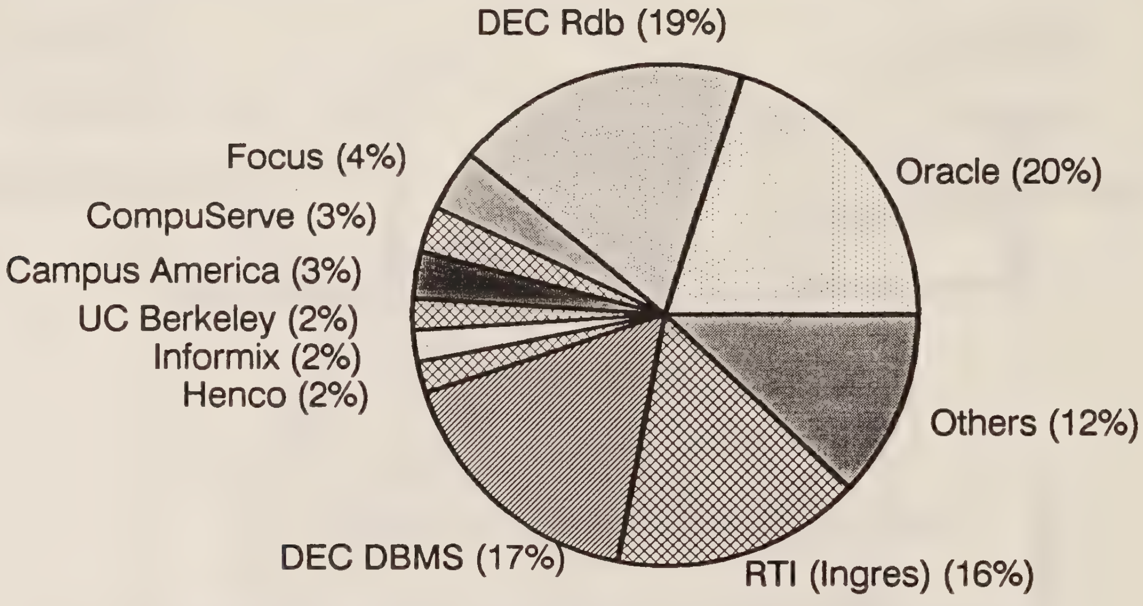
DSRI Standard Calling Interface

Back End

Rdb

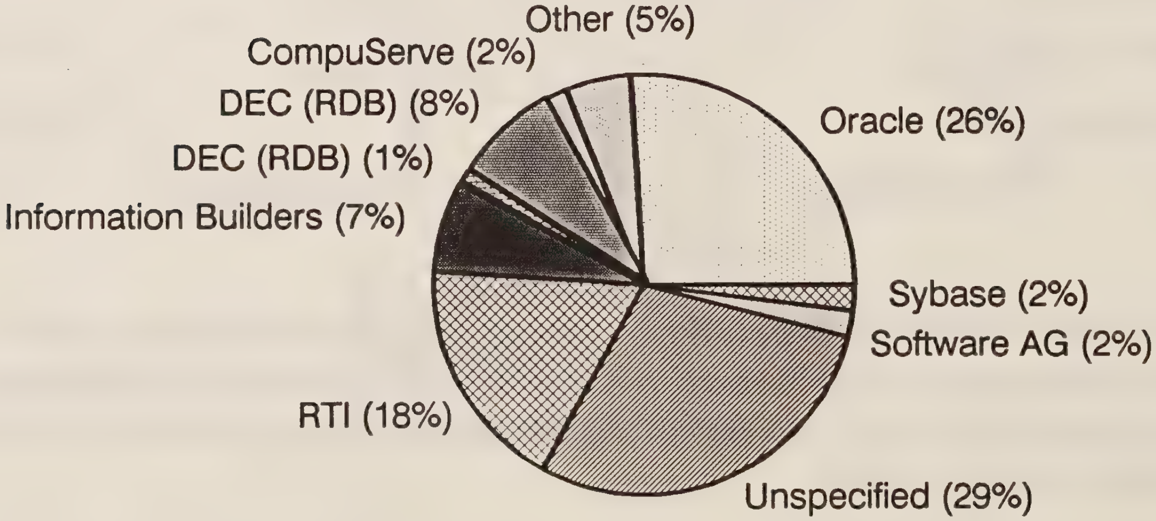
- DSRI provides a standard calling interface between interfaces and database managers. This has allowed third party vendors to develop both front and back-end products that work effectively within the VAX Information Architecture.

Database Market Shares

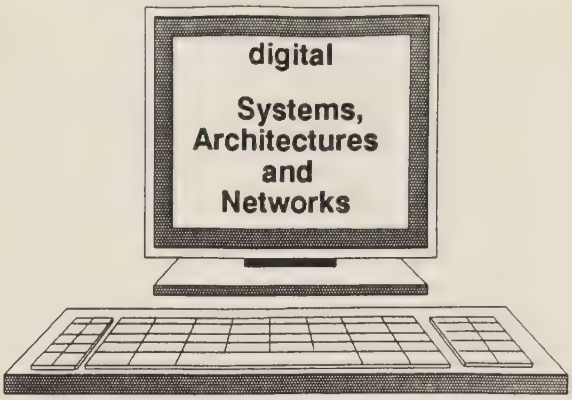


Source: Computer Intelligence (Digital Review)

Planned DBMS Software

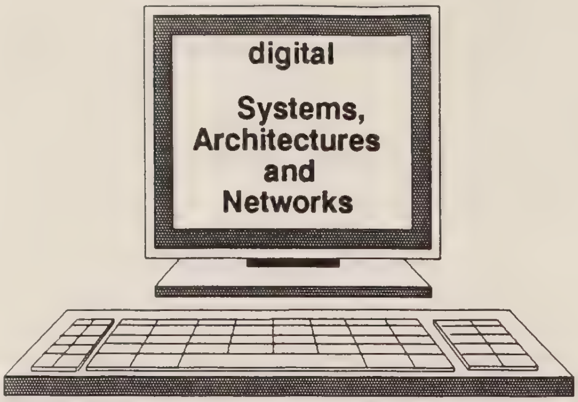


Source: Computer Intelligence (MISWeek)



Non-DEC Database Software

- General Software Implementations
    - > Ingres
    - > Oracle
    - > Informix
- Database Machines: Britton Lee
- Hybrid Implementations: Sybase
- DEC-Based DSRI-Compatible Systems
    - > Smartstar
    - > Interbase



General Software Systems

- Systems that run on multiple operating systems. All three products run complete implementations on PC-DOS, VMS and Unix. Ingres and Oracle also work on IBM VM/CMS operating systems. Oracle works on MANY other systems, such as Prime.

- Several IBM-based companies, including Cullinet, Information Builders and Software AG have begun to make VAX products available.

- A significant advantage of these systems is that they allow a common development environment and user interface on heterogenous hardware platforms.

- Although there are subtle differences between the software products, most include the following capabilities:

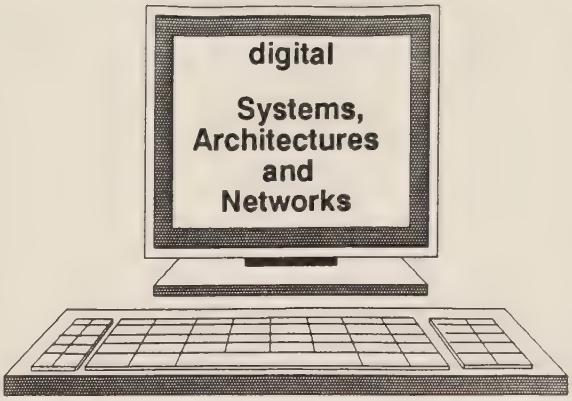
  > A SQL Interface

  > A Query By Forms Interface

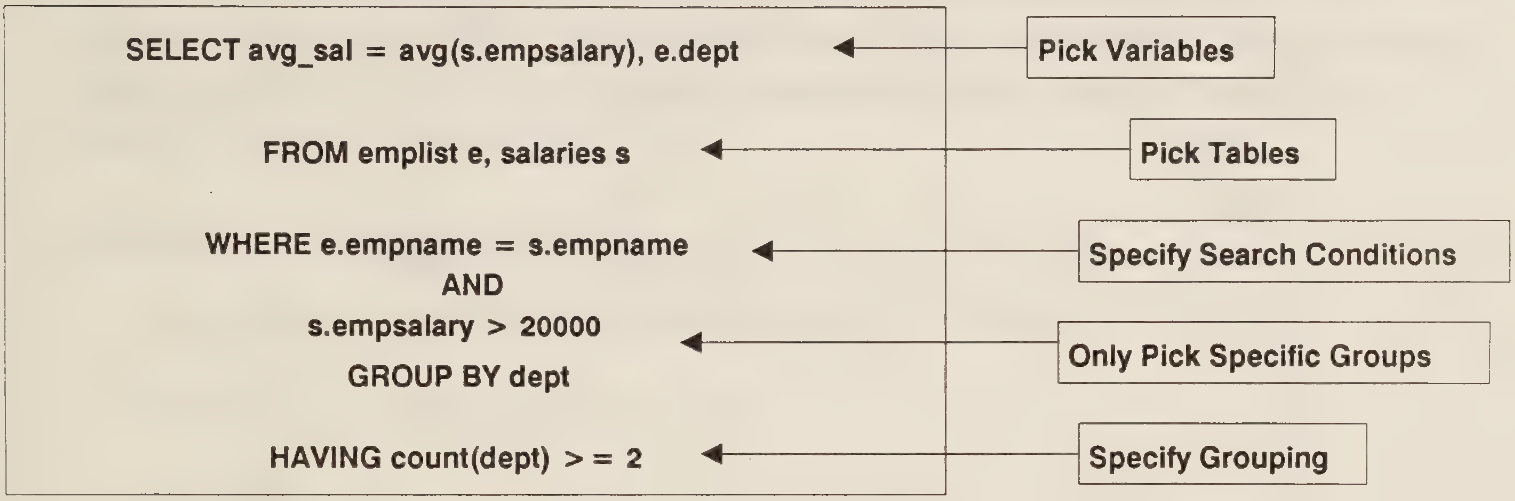
  > A Report Writer

  > A 4GL Based Application Generator

  > Embedded SQL Support



SQL Interfaces



```
SELECT avg_sal = avg(s.empsalary), e.dept
FROM emplist e, salaries s
WHERE e.empname = s.empname
AND
s.empsalary > 20000
GROUP BY dept
HAVING count(dept) > = 2
```

Pick Variables

Pick Tables

Specify Search Conditions

Only Pick Specific Groups

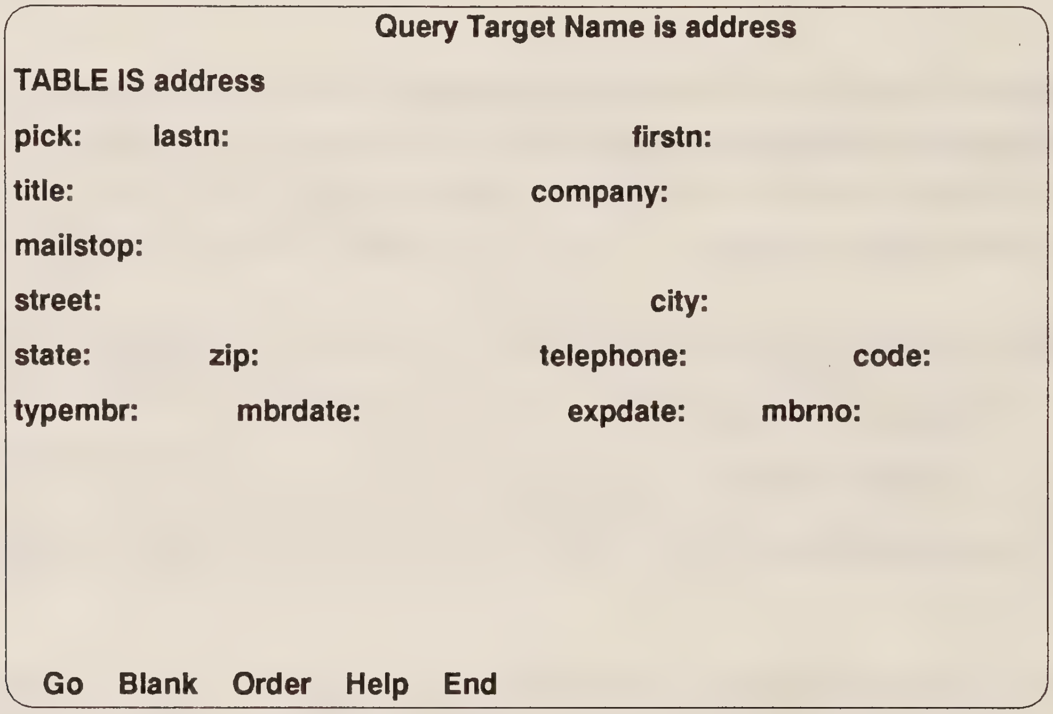
Specify Grouping

- A terminal monitor allows a user to feed in "raw" SQL statements and then look at the results. This is frequently used by the database administrator to add new tables, modify storage structures, change security and other similar functions.

- Usually, your users will prefer to use a more intuitive interface, such as a Query By Forms system, rather than master the intricacies of SQL.

- Programmers will need access to a terminal monitor to test SQL statements before they embed them in either a third generation language program (i.e. Fortran, Cobol) or the 4GL offered with the DBMS.

Query By Forms



Query Target Name is address

TABLE IS address

pick: lastn: firstn:
title: company:
mailstop:
street: city:
state: zip: telephone: code:
typembr: mbrdate: expdate: mbrno:

- Query By Forms (QBF) facilities are offered by most of the major vendors. This "point and shoot" mechanism spares you from having to master SQL.

- Ingres QBF will work on forms designed with the Visual Forms Editor (VIFRED) or will create a default form. Append, Retrieve, and Update operations are all supported.

- A JOINDEF joins several tables and allows for master detail relationships and specification of update and delete rules.

Report Generators

- Vendors are offering two types of report generators: the traditional command driven syntax and forms-based tools for constructing reports. Although the forms-based tools are easier to use, command driven systems are still more powerful.

- Features to look for include:

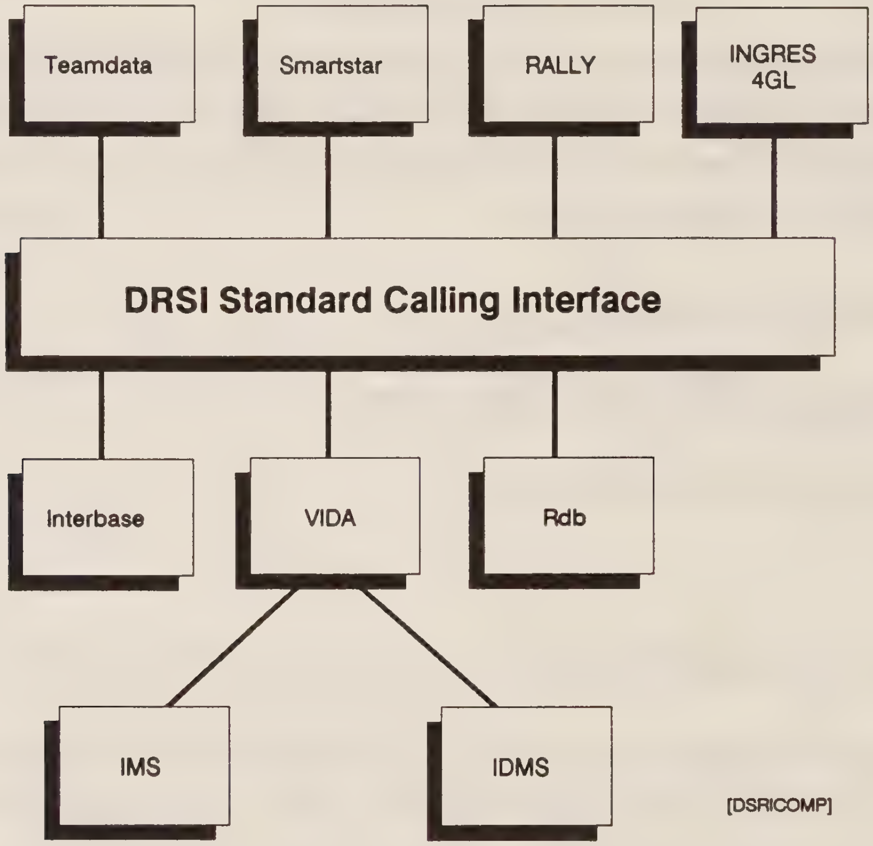
    > Report Aggregation and Calculation

    > How much SQL Can Be Used

    > Breaks

    > Column and Area Definition

DSRI Compatible Systems

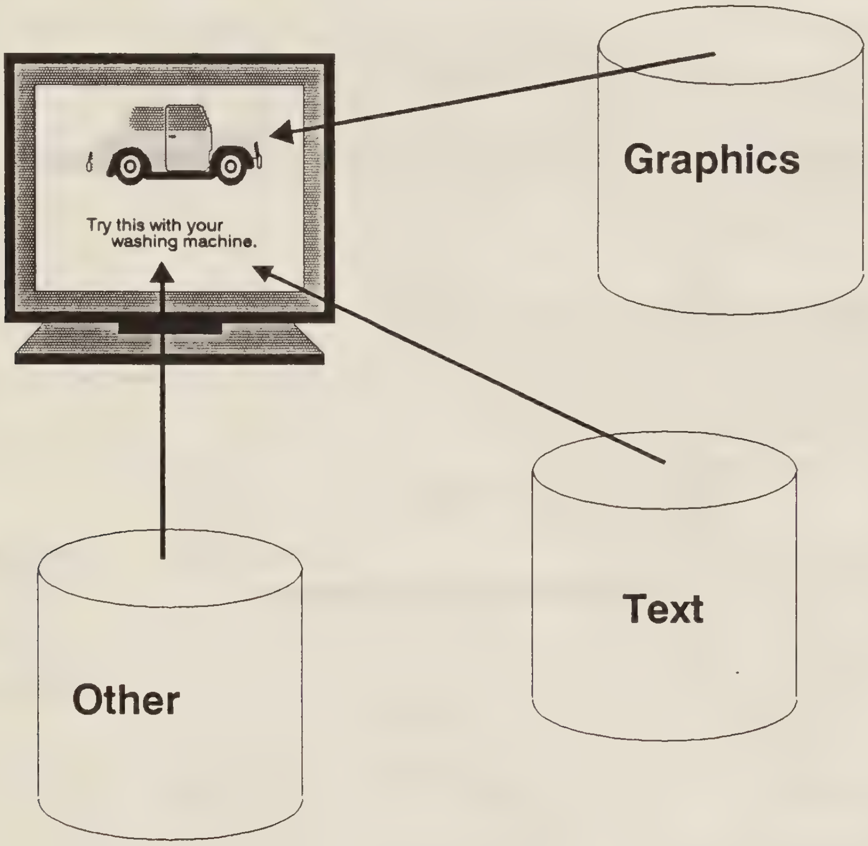


- Due to DSRI compatibility, Interbase front-ends can be used with Rdb, VIDA and Interbase back-ends. A product under development will add access to VAX RMS files.

- Application Generators, such as the Application Factory and Smartstar will work with these products as well as Rdb.

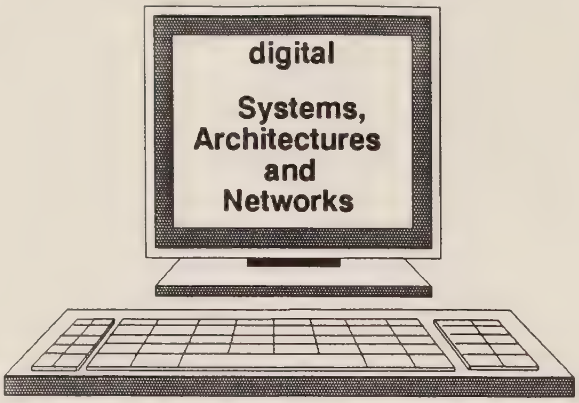
- A Mouse-driven interface (PICTOR) and a Query By Forms capability have been announced for the next release.

BLOBs

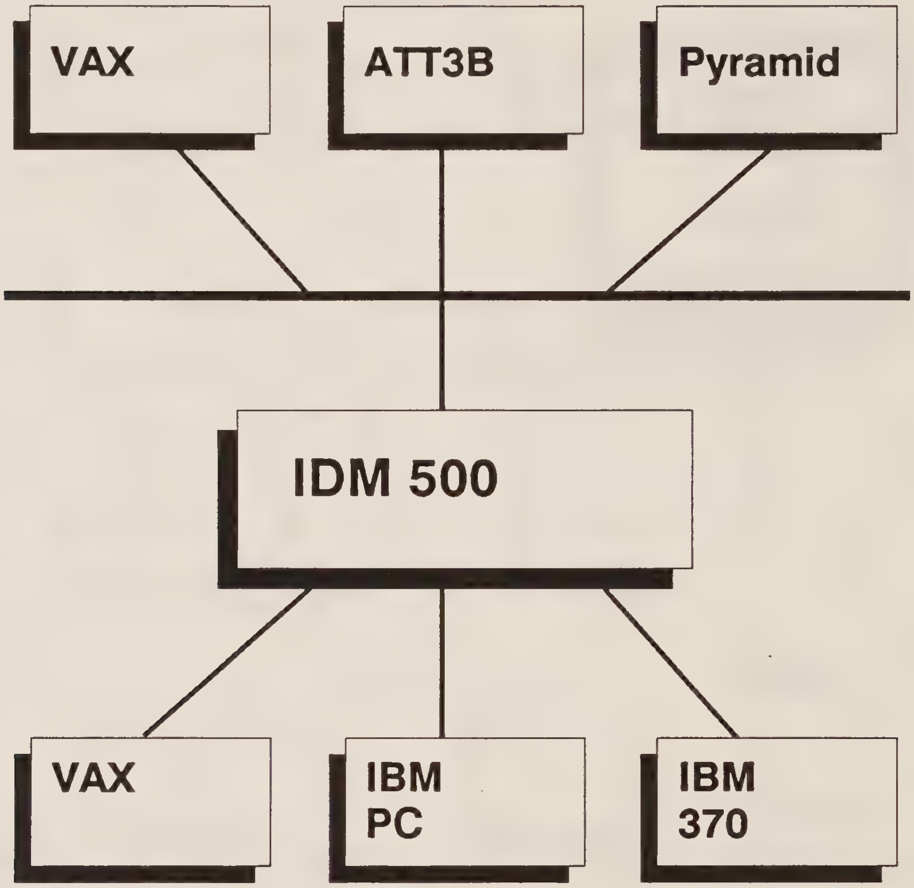


- Basic Large Objects allow the inclusion of text and graphic images into the database through the use of pointers.

- While this does not provide the functionality of dedicated free-text database systems, it does provide an important enhancement to the relational model.



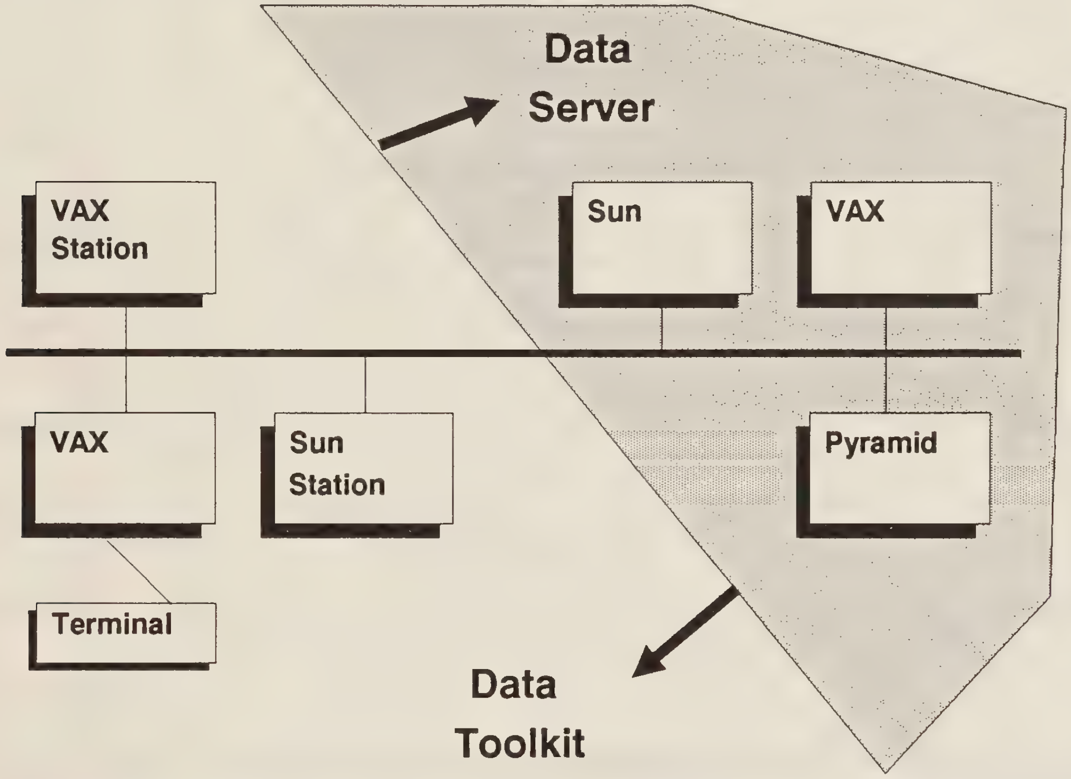
Database Machines (Britton Lee)



- Britton Lee machines support both XNS and TCP/IP. It does not support DECnet, but you can directly connect a VAX to a database machine.

- User interfaces differ across different front-end machines as Britton Lee depends on OEMs to provide those products.

Hybrid Implementations (Sybase)

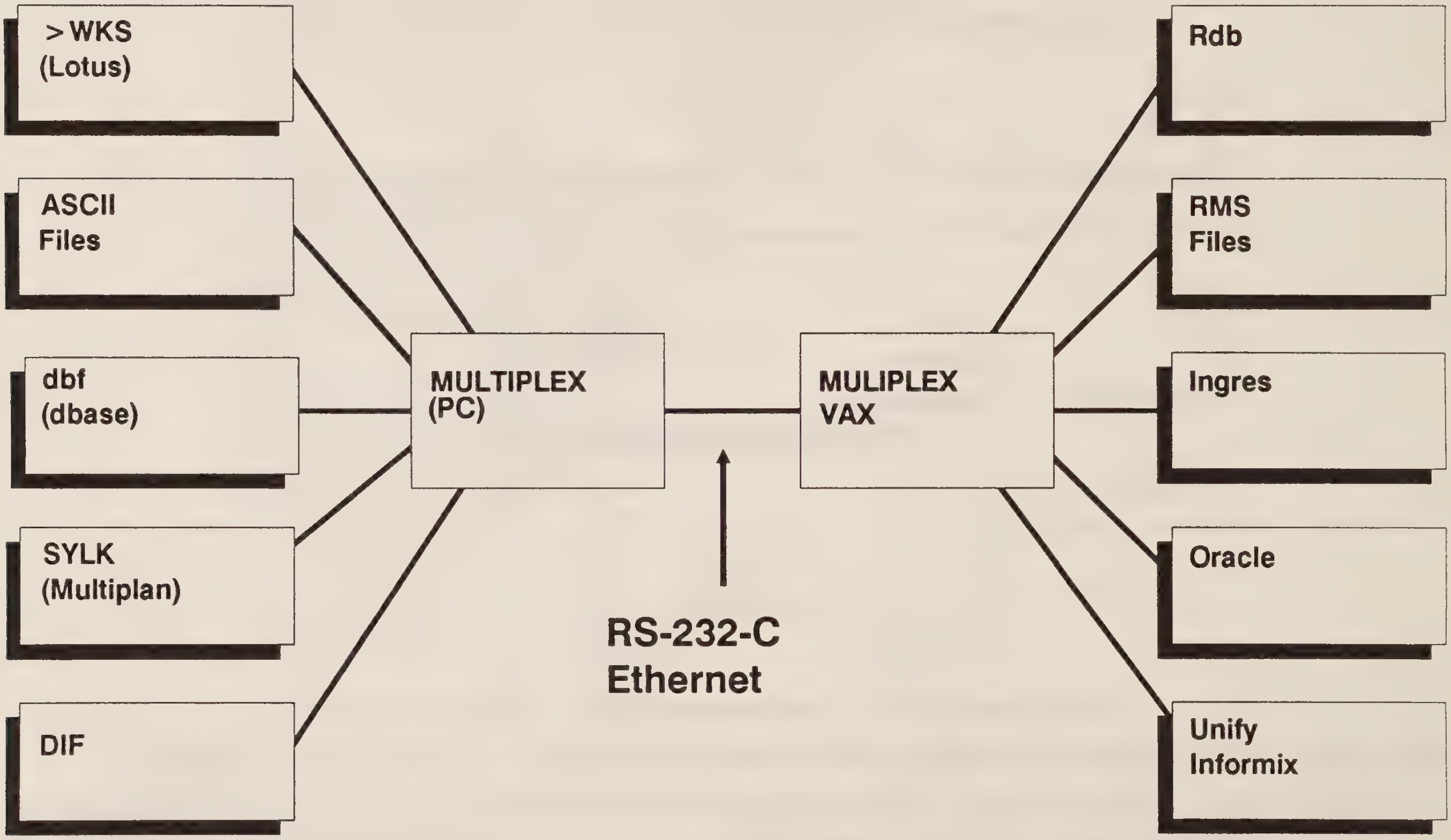


- One of the Sybase founders, Dr. Robert Epstein, is also a founder of Britton Lee. The company uses general purpose hardware, but dedicates the back-end (Data Server) to database functions, thus leading to dramatic performance increases.

- A similar user interface is provided by Metaphor. Metaphor uses a dedicated workstation and uses either a VAX Oracle database or a Britton Lee DBMS as a back-end.

Network Innovation's Multiplex

CL/I



>WKS (Lotus)

ASCII Files

dbf (dbase)

SYLK (Multiplan)

DIF

MULTIPLEX (PC)

RS-232-C
Ethernet

MULIPLEX VAX

Rdb

RMS Files

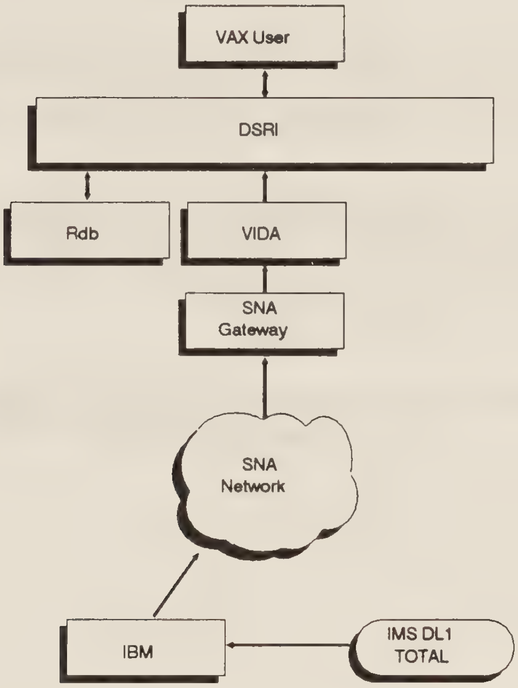
Ingres

Oracle

Unify
Informix

- This approach bridges the two different environments by offering a retrieve only capability and translation into a wide variety of popular DOS formats.

VAX/IBM Data Access (VIDA)



- This DEC product requires an SNA gateway. It interacts with Cullinet's IDB product to access IDMS databases and VSAM files. With Cullinet's Culprit software, data can be extracted from several other popular IBM systems.

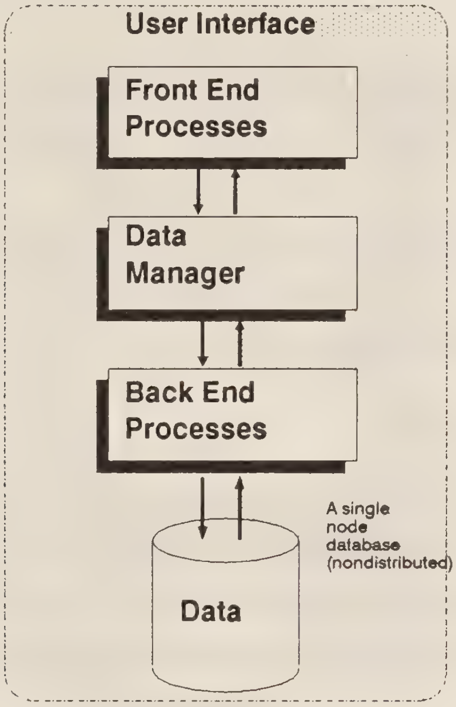
- VIDA is transparent to the user and looks like any other DSRI target database. Used for retrieval of data only. Retrieved data can be stored in a VAX database or file.

- Other companies with gateway products include Oracle and Relational Technology (Ingres).

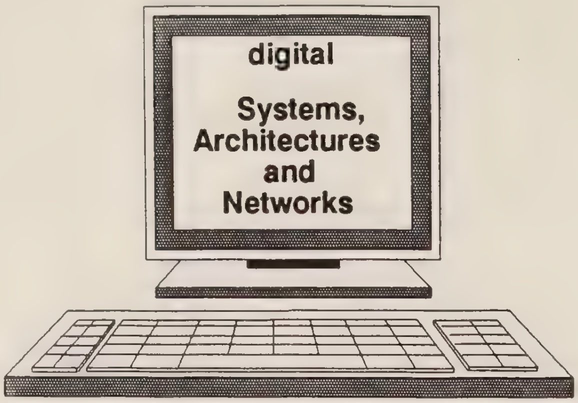
VAX Data Distributor

- This product extracts Rdb, VIDA-accessible, and other DSRI databases from target nodes. A new database is created on a target node.
- An optional feature is to have updates automatically transmitted from the source to the target databases, but only for Rdb databases. The DBA can specify the frequency of updates.
- Entire databases or selected subsets can be copied.

Introduction to Distributed RDBMS



- Gateways allow the front-end of one system to access the back-end of another system. DEC's VIDA gateway allows a front-end that is DSRI compatible to access an IDMS database.
- Networked databases allow the front-end of one system access a particular back-end of that same system.
- A Distributed database allows a front-end to access multiple back-ends without knowing the location of any of the data.
- Heterogenous distributed systems are beginning to appear.



Distributed RDBMS

- Differs from simple front/back-end separation by allowing multiple back-ends with the user being unaware of the location of the data.

- Two factors are important in examining a distributed database product:

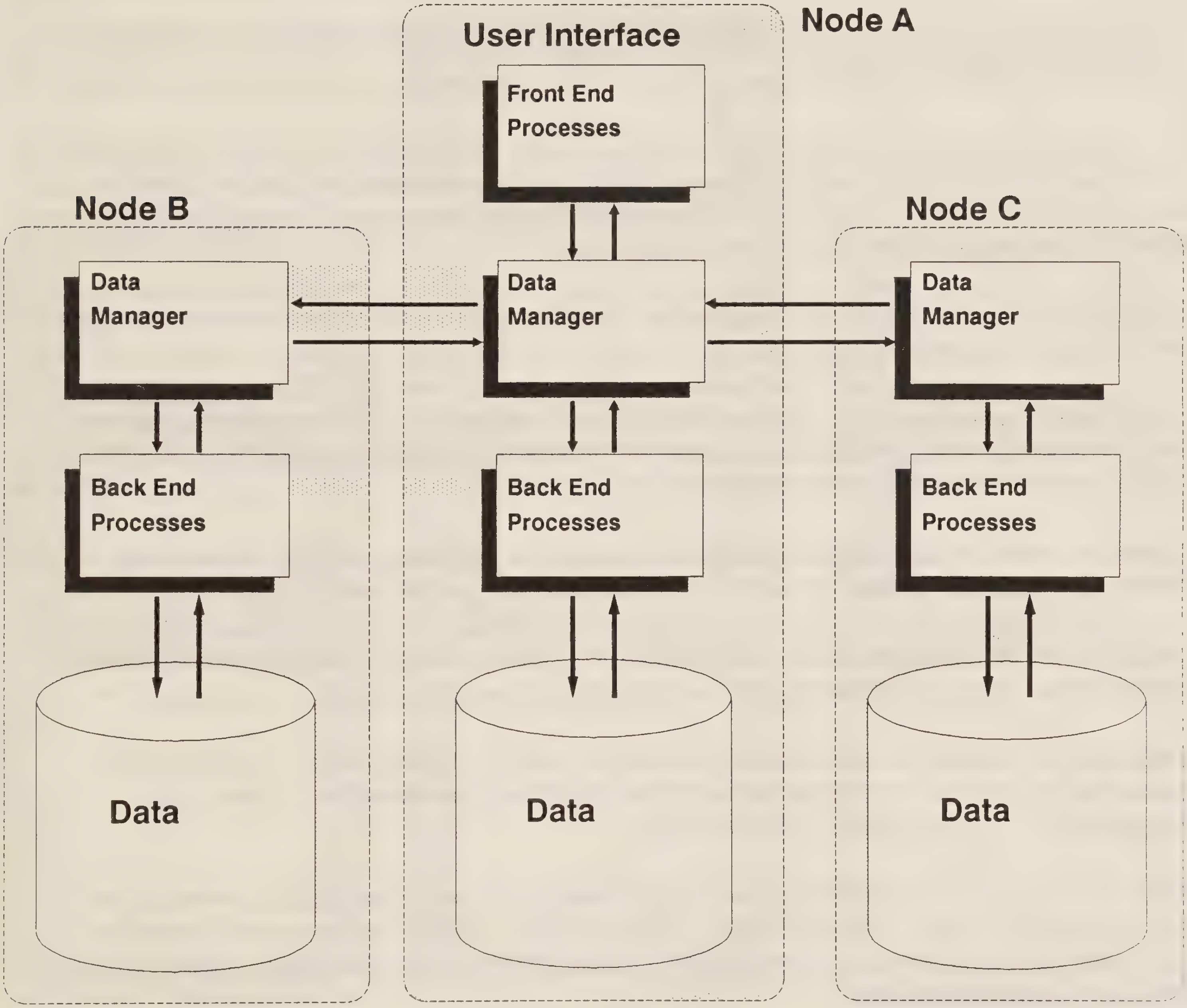
  > Communications Protocols

  > Distributed Updates

- Most vendors have announced support for a variety of communications protocols for retrieve and single site updates. Ingres distributed databases currently support asynchronous communications as well as TCP/IP and DECnet. Oracle has announced support for several environments.

- Several vendors have announced support for two-phase commits, allowing for multiple site updates.

Distributed DBMS Model



User Interface

Node A

Node B

Node C

Front End Processes

Data Manager

Data Manager

Data Manager

Back End Processes

Back End Processes

Back End Processes

Data

Data

Data

Date's Dozen *

Rule Zero: To the user, a distributed system should look exactly like a nondistributed system.

1. Local autonomy. All data on a given node is owned and managed by that node's users. All operations at a node should be controlled by that node; it should not be dependent on some other node to keep running.

2. No reliance on a central site. It serves as a bottleneck, and if the central server goes down, the entire network is down.

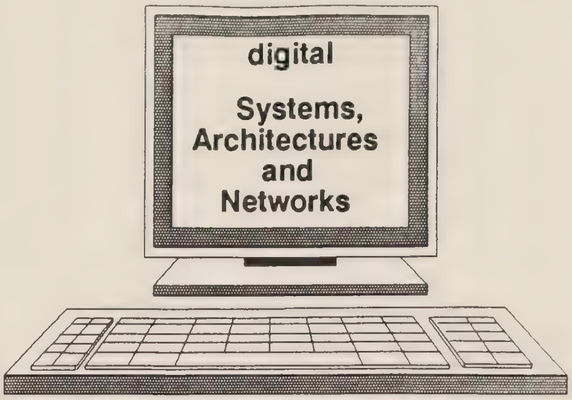
3. Continuous operation. Planned system downtime should never be required, except when new versions of the DBMS software are installed. Even then, only the node on which the new version is installed should be unavailable.

4. Location independence. Users shouldn't have to know where data is physically located. It should all appear to users as though it were on the local node.

5. Fragmentation independence. All the data in a given relation need not be resident on a single node. Fragmentation should be invisible to the user.

6. Replication independence. Data replication should be transparent to users and to application programs. A program should run identically whether its updates are propagated to 1 or 20 copies of the relation.

7. Distributed query processing. Query optimization should take a global view of the entire system to reduce network traffic and maximize overall performance. Once the query has been globally optimized, local optimization should take place at each node from which data is required.



8. Distributed transaction management. If updates are to be performed to nodes other than the local one, a two-phase commit protocol is required to make transactions atomic over the entire system.

9. Hardware independence. Hardware independence helps users migrate applications to the most cost-effective platform rather than getting stuck with a particular vendor.

10. Operating system independence. Corporate data may reside on an IBM system running MVS/XA or VM/CMS, or on a DEC VAX running VMS. That data should be accessible to UNIX computers.

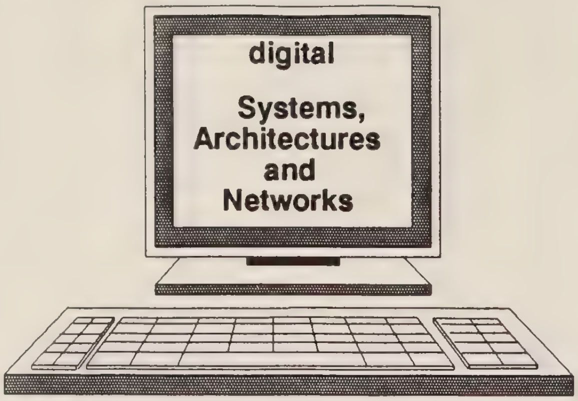
11. Network independence. It shouldn't matter to applications what hardware supports the network or what software protocol is used. DECnet, AppleTalk, TCP/IP, NFS, or SNA running on synchronous or asynchronous lines, Ethernet, microwave links, or juice cans and string--the DBMS must conceal all the details from the application.

12. DBMS independence. DBMS at different nodes must be able to communicate, whether or not they come from the same vendor.

These rules are ideals or objectives for distributed database systems.

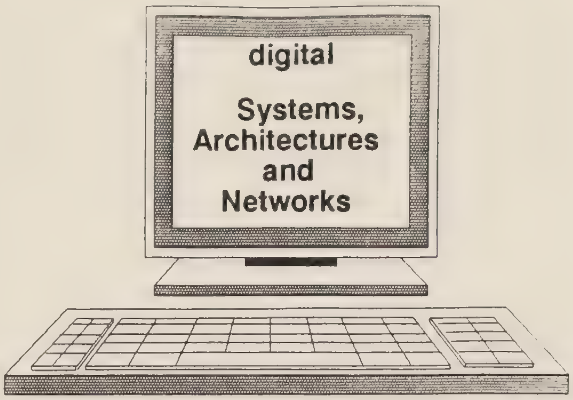
You can use these rules as a yardstick to measure vendor compliance/claims.

* Reference: Date's Dozen, UNIXWORLD, April 1988, p. 58



Distributed RDBMS Today

- Most vendors currently offer either retrieval distribution or single-site update.
- Several vendors are close to (or claim to be) offering multiple-site updates within one transaction.
- Fragmentation will allow a single table to be distributed, either horizontally or vertically.
- A longer-term goal is location transparency where copies of the same of data can be stored and automatically updated at several sites.



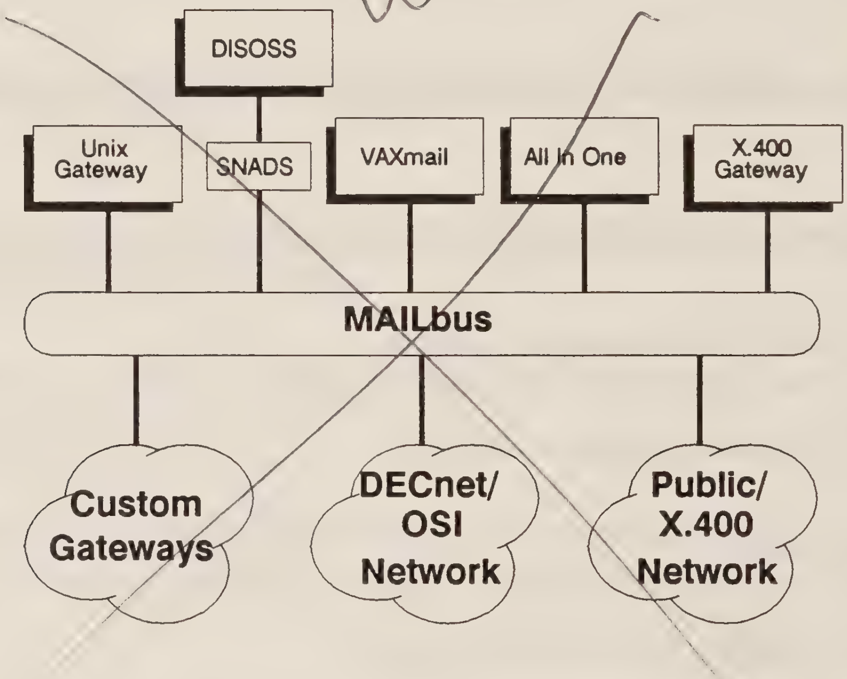
Management Pointers

Management understanding and support of a corporate database strategy.

- A database design that reflects a broad view of corporate data.
- A third-normal form database structure.
- End user participation in data analysis.
- Use a data dictionary.
- Get a competent database administrator.
- Select the right type of database model.
- Performance tuning.

Mailbus

WRONG!

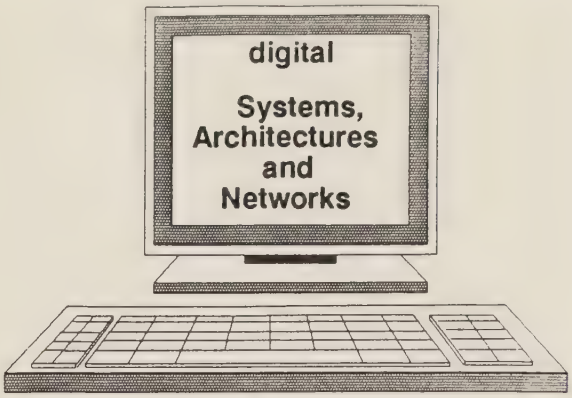


- An architecture for mail systems. Mailbus has several components including Message Router, a common messaging system for all user interfaces.

- VMS Mail and All-in-One are two possible user interfaces. Users may also construct their own.

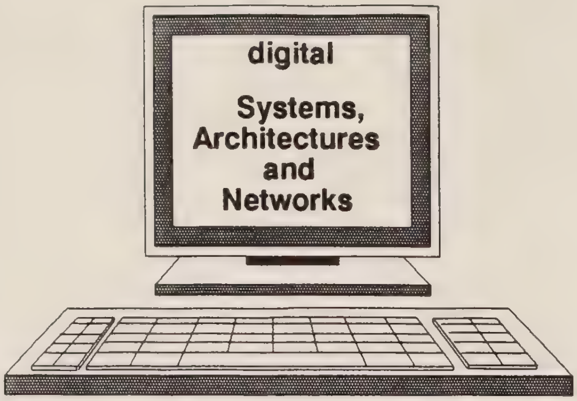
- Gateways provide integration into other message handling systems, particularly SNADS for the IBM world and X.400. The X.400 gateway is particularly important and will be covered again in the OSI section.

- A Directory helps translate foreign addresses into DECnet style addressing schemes.



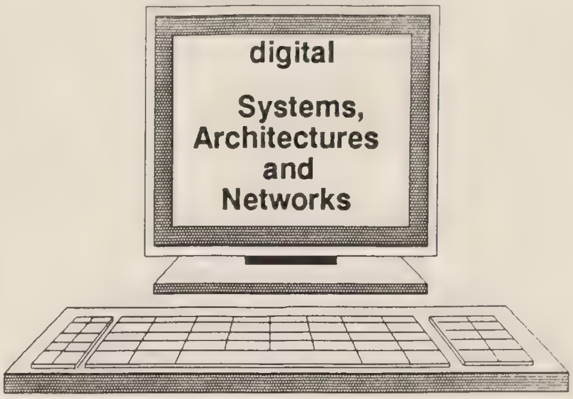
Bulletin Boards

- Cross between mail and phone. Allows you to post messages in a conference on a particular topic. Other people can read that message and then post a response.
- Bulletin boards have been used for years in the Unix Usenet and on MANY PC-based systems. Bulletin boards are especially appropriate to allow participation in the planning process and to distribute new information.
- DEC's bulletin board system is VAXNotes, which is typically linked in as a menu option in All-in-One.
- VAXNotes lets you use a text editor or word processor to prepare the notes to avoid that typed with gloves on message format.
- Conferences can be public or private. Private conferences are limited to specific groups.
- You can mark the conference you wish to track. Once in a particular conference, you can search by key-word to see if there are any notes you are interested in.
- VAXNotes can be built on top of a remote DECnet allowing wide-area access to bulletin boards.



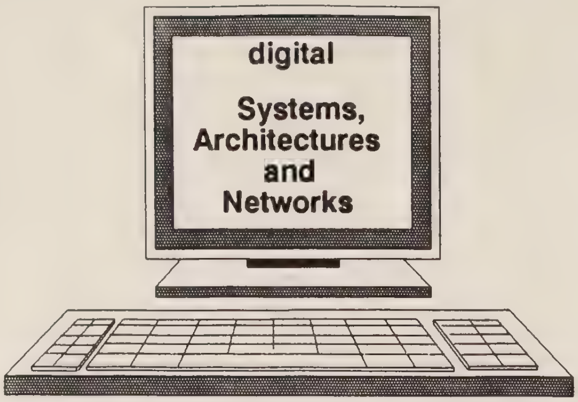
All-in-One

- Centerpiece of DEC office automation efforts. Runs on PCs, VAXes.
- All-in-One is a fancy menu driver. It lets you link to mail, word processing and several other facilities. Customized applications let you add database access, or any other resource you have on your system.
- Can be licensed on personnal use basis. For example, you could use All-In-One 200 times. After that, you buy more if you need it. Standard licensing is still available. This option could save money if only a few people use the product.



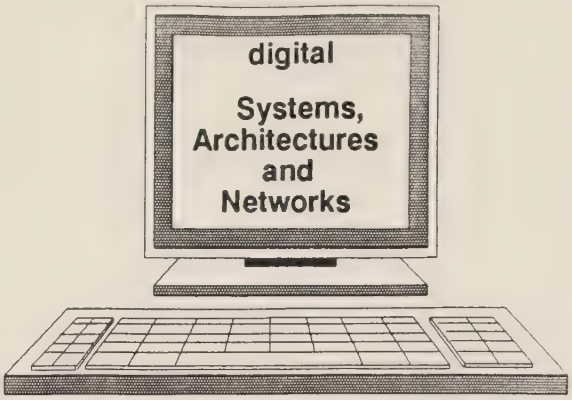
WPS/Plus

- There are many word processors available in a VMS environment, including WordMarc, Word-11, and WordPerfect. DEC has announced a specification for a Digital Document Interchange Format (DDIF). DDIF is part of a broader Compound Document Architecture (CDA). This will allow interchange of documents between different software packages.
- DEC's package is WPS. It runs on DECmates, VAX PCs and uses the same keypad as the VAX EDT editor.
- WPS uses the same folder concept as the MAIL system.
- Fancy features include special characters (greek, math symbols), list processing for mail merges, simple math functions, spelling checker and macros (User Defined Procedures).
- DEC's External Document Exchange (EDE) provides interchange with IBM DCA environments and WANG OIS systems. Look for dramatic increases in document interchange capabilities.



Compound Document Architecture

- The Compound Document Architecture (CDA) is DEC's new venture into document preparation. The CDA consists of software packages that run under DECwindows. The packages are DECwrite and DECdecision.
- Both DECwrite and DECdecision have a "live link" capability. Data can be accessed anywhere in the network.
- DECwrite is a WYSIWYG editor. Can integrate and format documents containing text, graphics, images and certain application (database) data. Provides freeform and object oriented drawing tools. PostScript files are supported as well as DECchart, a business graphic package.
- DECdecision is a decision support tool. Uses DSRI for links to databases including IDMS/R on IBMs. Has a spreadsheet and nine types of charts for viewing the data.
- The CDA uses the Digital Document Interchange Format to exchange different types of information in a document (text, graphs, graphics, etc...).
- Several third party vendors also provide solutions to most document interchange problems.



Interleaf

what you see is what you pay for!

- What you see is truly what you get. Runs on VAXstations with at least 2 MBytes RAM. Using the DX filter, Interleaf can accept WPS documents. Once you've added graphics, it's harder to go back to the other format.
- Multi-font text, multi-column text and integrated graphics makes this a full-powered document production system. Interleaf also runs on Sun workstations and has hooks to several typesetting systems.
- Graphics capability includes both a free-form graphics editor and a rudimentary business graphics package. Once the data is in the system, you can pull up a library of over 40 chart/graph styles and try different styles on your data.
- Graphics symbols can be stored in clip-art libraries, then pulled up and put into your document.
- Style sheets allow you to create document templates for memos, letterheads, etc...

Alis

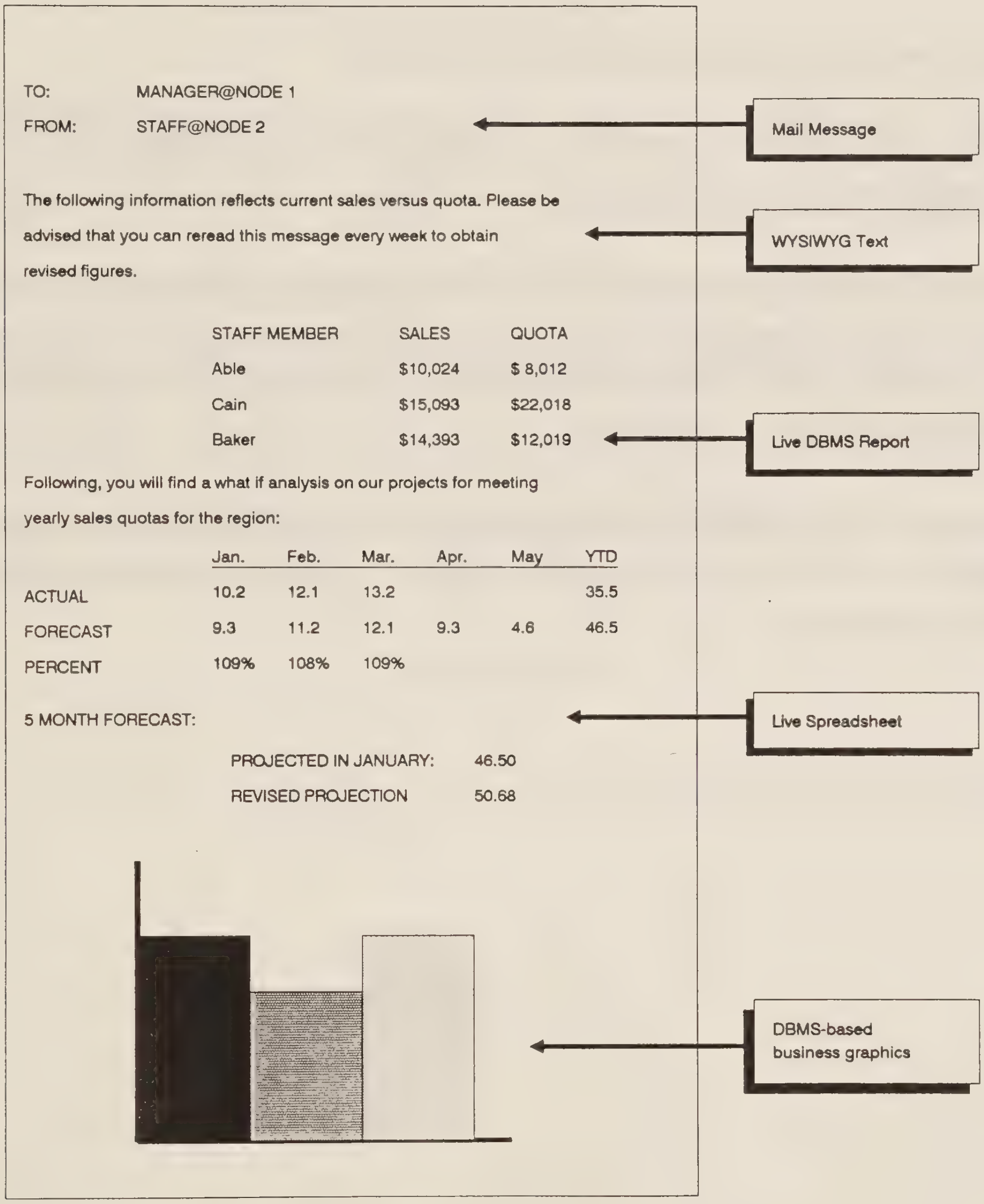
- Alis, now running on Sun, DEC and IBM Workstations is a product by Applix. Alis provides an example of a truly integrated compound document production system.

- Portions of the document can be text, graphics, business graphics, spreadsheet or DBMS report. The system has an open architecture allowing the (sophisticated) user the ability to define new types of documents such as voice mail, computer animation or statistical analysis package.

- Documents are live, meaning that the data is fed into the document at the time it is read, not at the time it is created. A live document can be mailed to another user. When the user reads the document, the latest version of the data will be used to update the document until it is frozen.

- This functionality does not come cheap. While not required, it is desirable that each user have a workstation with more than 4 MBytes of memory.

Integration in an OA Environment (Alis)



TO: MANAGER@NODE 1
FROM: STAFF@NODE 2

The following information reflects current sales versus quota. Please be advised that you can reread this message every week to obtain revised figures.

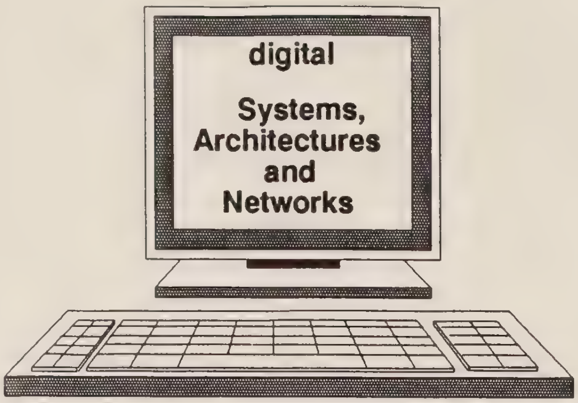
STAFF MEMBER	SALES	QUOTA
Able	$10,024	$ 8,012
Cain	$15,093	$22,018
Baker	$14,393	$12,019

Following, you will find a what if analysis on our projects for meeting yearly sales quotas for the region:

	Jan.	Feb.	Mar.	Apr.	May	YTD
ACTUAL	10.2	12.1	13.2			35.5
FORECAST	9.3	11.2	12.1	9.3	4.6	46.5
PERCENT	109%	108%	109%			

5 MONTH FORECAST:

PROJECTED IN JANUARY: 46.50
REVISED PROJECTION 50.68



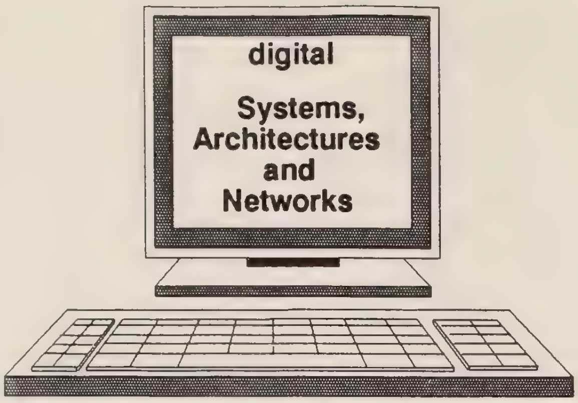
DIGITAL SOFTWARE PRODUCTS

Key Concepts in This Section

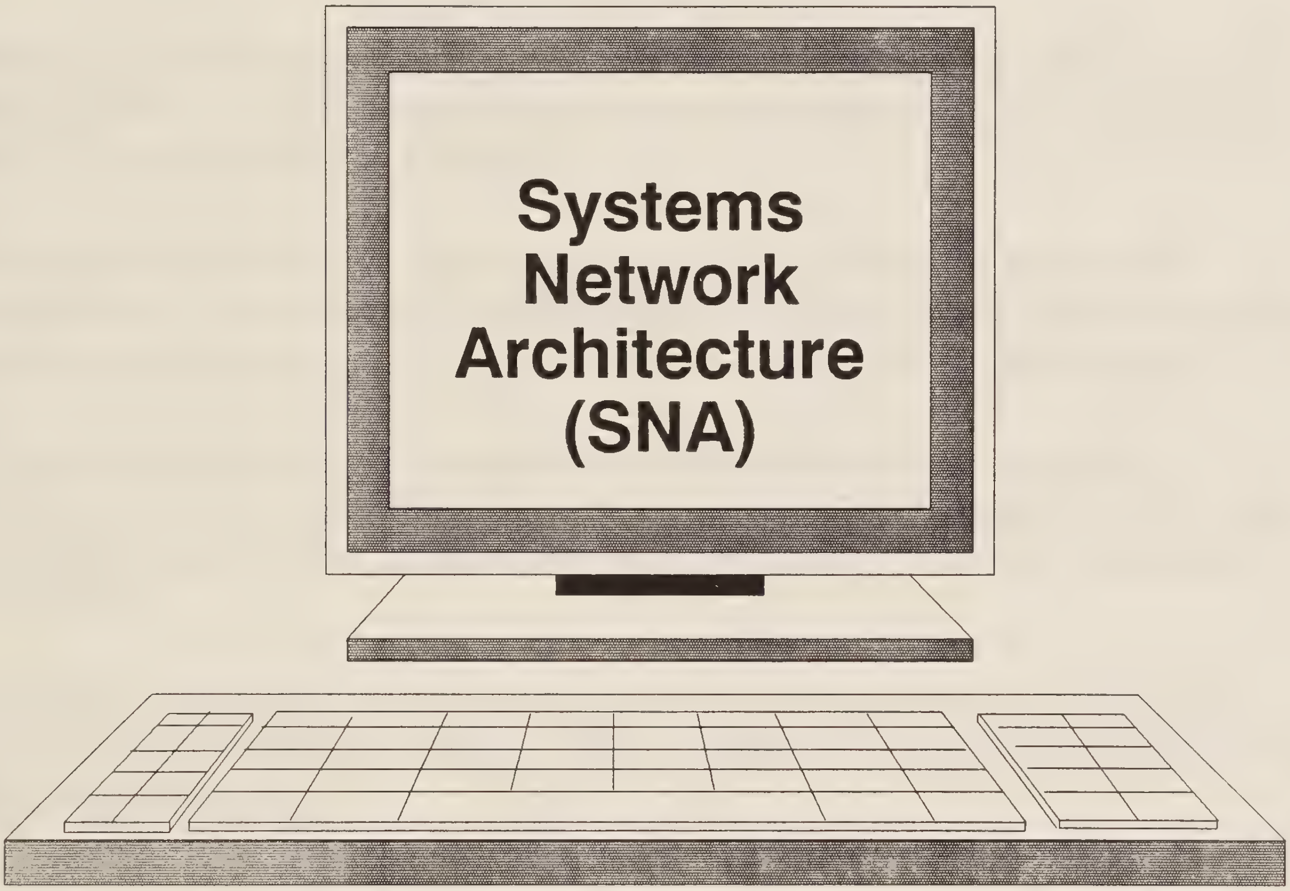
- Relational Databases (Local and Distributed)
- Two DEC approaches: the VAX Information Architecture and the Digital Standard Relational Interface.
- Mailbus is an important architecture for interconnecting mail systems and diverse user interfaces. Currently, OA environments such as PROFS, DISOSS, and X.400 systems such as MCI Mail and Data General CEO can be linked into Mailbus.
- The Compound Document Architecture and the Digital Document Interchange Format are DEC's attempts to integrate various document production systems.

"I wish people would stop calling me a 'raider' when I put a billion or so dollars into a company and then make a few suggestions to make management more efficient. After all, shareholders are the owners of the company."

T. Boone Pickens

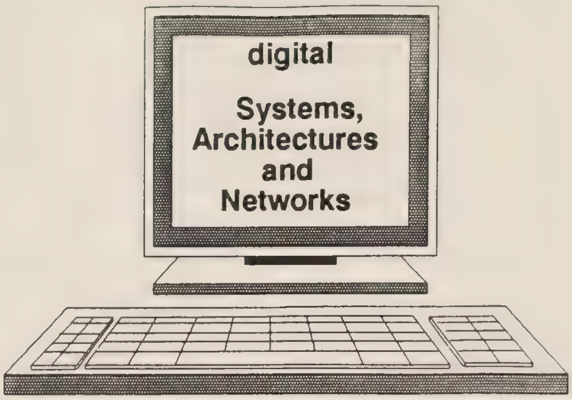


DIGITAL SOFTWARE PRODUCTS



Systems Network Architecture (SNA)

SYSTEMS NETWORK ARCHITECTURE



Overview

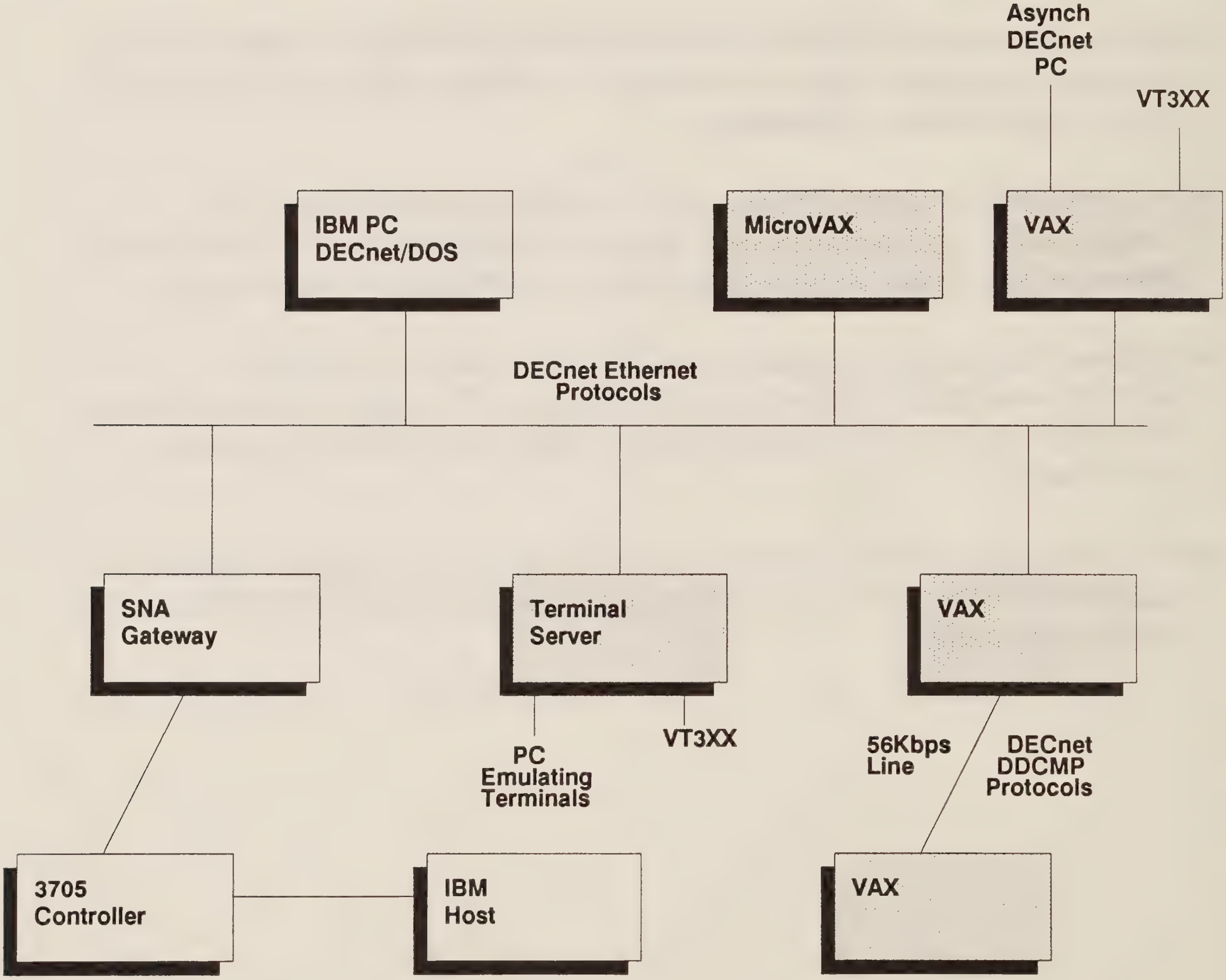
- SNA is an essentially hierarchical network architecture. SNA is slowly moving into a peer to peer environment with the advent of LU6.2 and PU2.1 compatible workstations.

- SNA includes a family of protocols providing different layers of functionality. SNA support can range from simple terminal emulation to advanced services that fully integrate two different environments.

- Different hardware configurations are available depending on performance and functionality requirements. Configurations can range from dedicated 32-bit gateways at the high end, to simple protocol converters.

- Two other important architectures are Bisync and Netbios. Netbios is used with PC networks. Bisync is an old set of protocols still in use in a few environments.

Integration of IBM Equipment



Asynch DECnet PC

VT3XX

IBM PC DECnet/DOS

MicroVAX

VAX

DECnet Ethernet Protocols

SNA Gateway

Terminal Server

VAX

PC Emulating Terminals

VT3XX

56Kbps Line

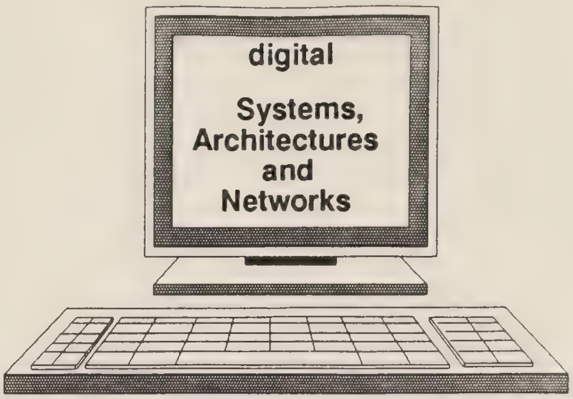
DECnet DDCMP Protocols

3705 Controller

IBM Host

VAX

SYSTEMS NETWORK ARCHITECTURE

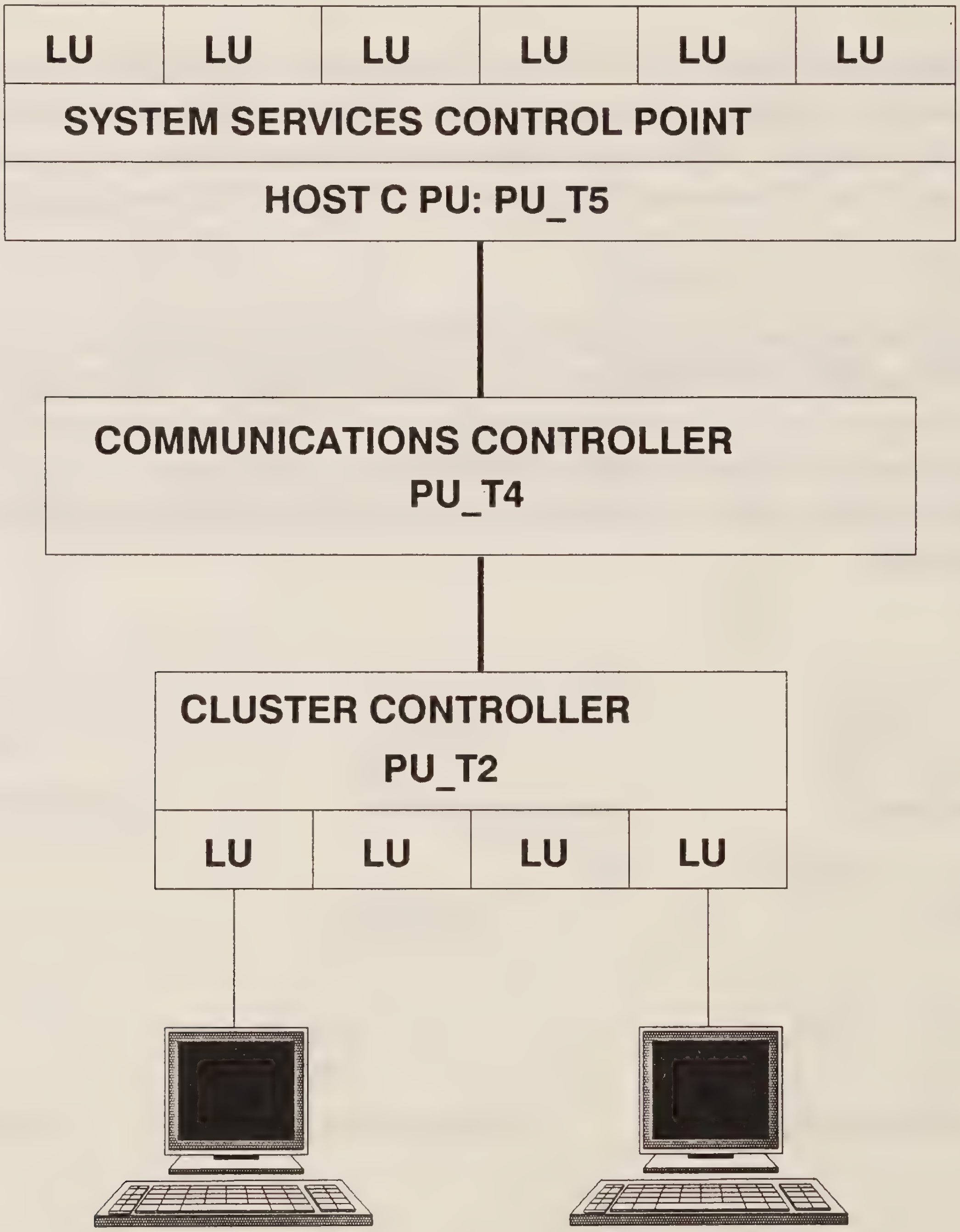


Features

- The SNA Gateway allows the DECnet to appear to the SNA host as a 3274 Cluster Controller. The use of SNA Access Routines then permit VAX users to emulate 3270 terminals and also perform more advanced functions such as Advanced Program To Program Communications (APPC).

- One of the challenges in integrating IBM and DEC networks is that the software in the two environments is usually different. DBMS Gateways are software products that make data in one DBMS format available to another system that uses a different DBMS environment. An example of this is DEC's VIDA product that makes data in an IDMS database available to Rdb.

An SNA Domain



LU | LU | LU | LU | LU | LU

SYSTEM SERVICES CONTROL POINT

HOST C PU: PU_T5

COMMUNICATIONS CONTROLLER
PU_T4

CLUSTER CONTROLLER
PU_T2

LU | LU | LU | LU

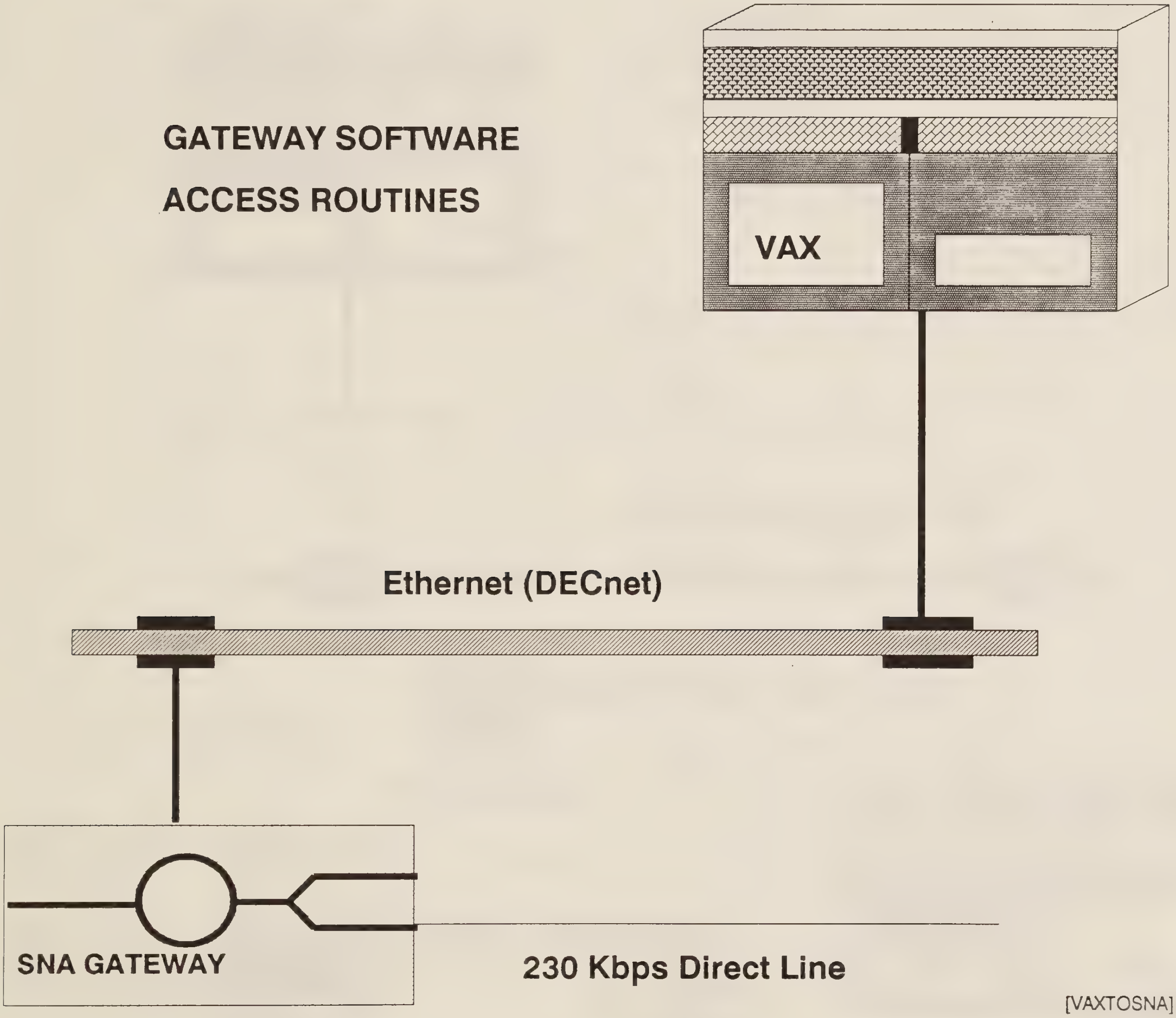
SNA Components

- A Physical Unit is a type of hardware:
    - > A PU 5 is a Host
    - > A PU 4 is a Communications Controller
    - > A PU 2 is a Cluster Controller
    - > A PU 2.1 is a new form of PU 2 which allows peer to peer communications
- Most Non-IBM SNA implementations emulate a PU 2.
- Logical Units are software or microcode that run on a PU.
- A System Services Control Point (SSCP) controls a particular domain associated with a host.
- AN LU 2 is basically a 3270 terminal.
- LU 6.2 allows the use of Advanced Program to Program Communication (APPC).

DECnet/SNA Gateway

- Four types of DECnet/SNA Gateways:
  - > A VAX with VMS/SNA
  - > The old PDP-based Gateway
  - > The Synchronous Transport Gateway
  - > The Channel Transport Gateway
- The gateway only provides a transport layer interface to the SNA environment. Access Routines are used for specific applications.
- VMS/SNA uses a synchronous communication board such as the DSV11 for the Q-Bus. VMS/SNA is a software package that provides the gateway function. This software also allows connectivity via X.25.
- The ST gateway provides up to 256 kbps total bandwidth. This could be configured as four 64 kbps lines. The gateway supports up to 128 logical units (sessions). This device is based on the DEMSA MicroServer architecture and can be changed into a DECnet Router or X.25 Gateway.
- The CT gateway provides a channel attach to a 370 architecture mainframe. Up to 255 logical units are supported. Speeds of up to 1.2 mbps are supported.

VAX to SNA Gateways

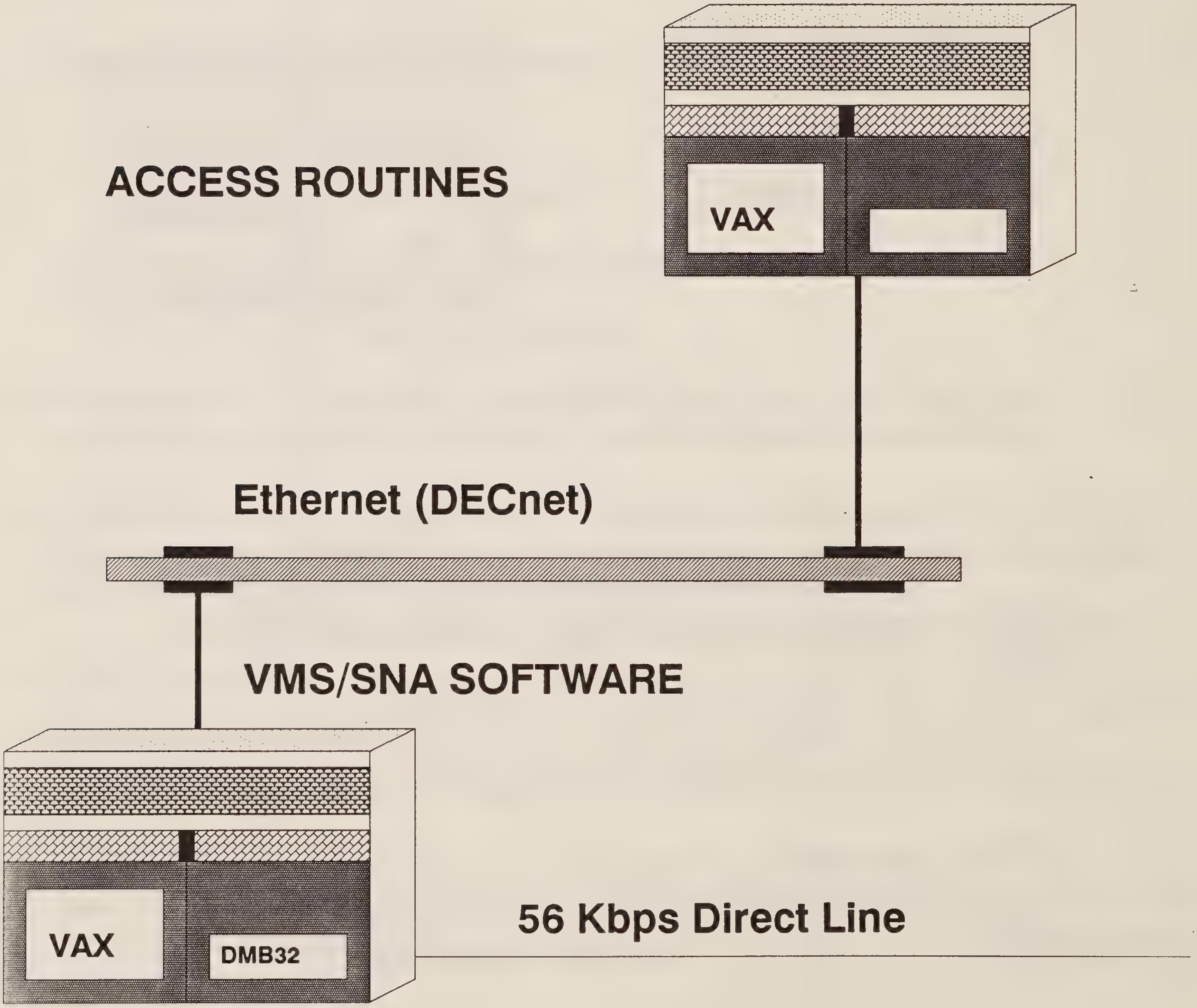


GATEWAY SOFTWARE

ACCESS ROUTINES

[VAXTOSNA]

VMS/SNA Software



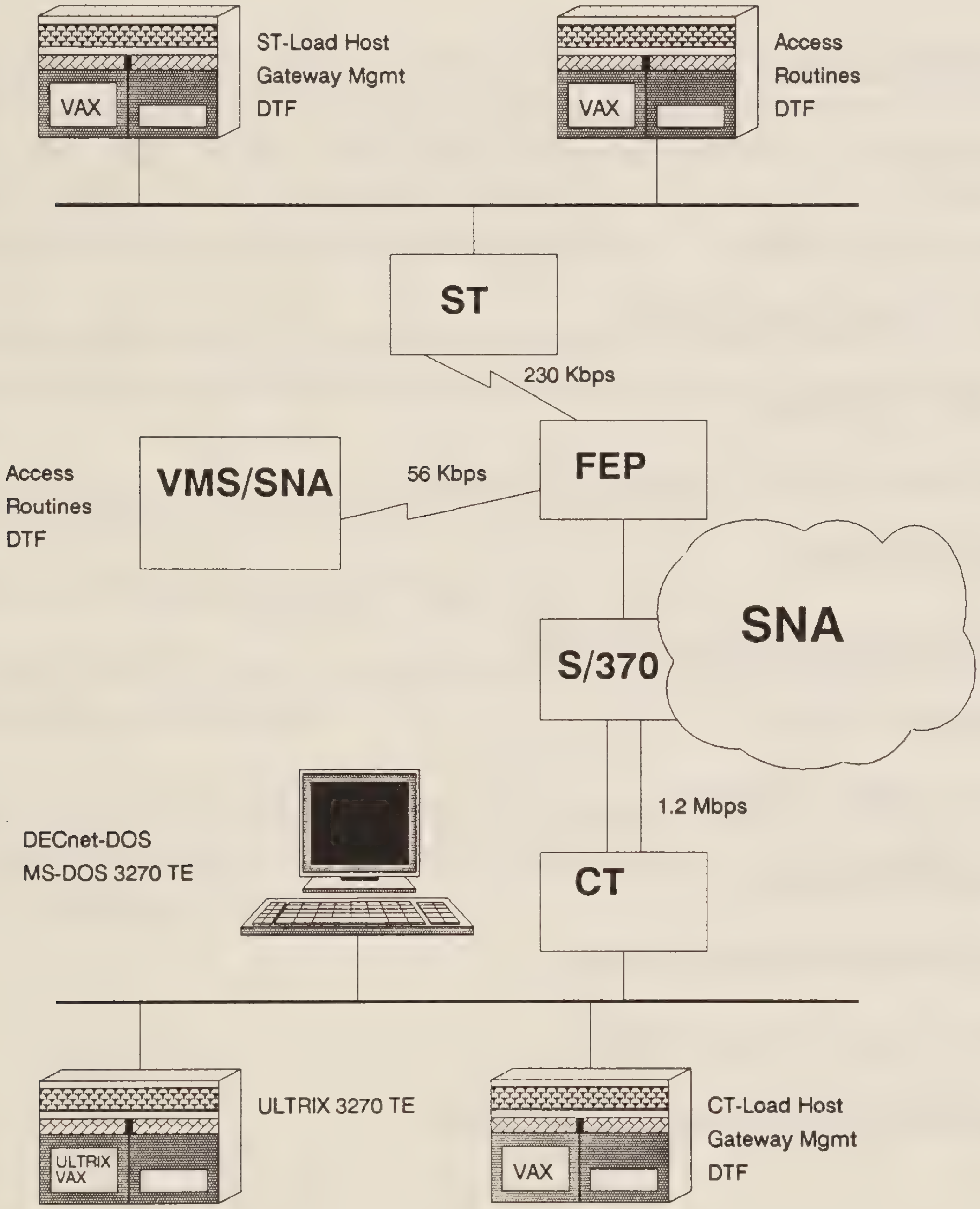
ACCESS ROUTINES

Ethernet (DECnet)

VMS/SNA SOFTWARE

56 Kbps Direct Line

SNA Gateways



DECnet/SNA Access Routines

- Gateway Management Software
- Basic Services
  - > Remote Job Entry
  - > 3270 Terminal Emulation
  - > Printer Emulation
  - > Distributed Host Command Facility
- Advanced Services
  - > DISOSS Document Exchange
  - > Message Router
  - > Data Transfer Facility
- Programmatic Access
  - > APPC Programming Library
  - > 3270 Programming Library
  - > Application Programming Interface

Basic Services

- DECnet/SNA VMS Remote Job Entry. Allows VAX systems to function as SNA/RJE workstations in order to submit batch jobs to the IBM host and receive job output. VAX to IBM RJE streams look like card reader to the IBM host. IBM to VAX RJE streams look like a printer to the IBM host. Data downloaded is normally saved in a file.

- DECnet/SNA VMS 3270 Terminal Emulator. Allows a VAX ASCII type terminal to interact with programs on the IBM host. Keyboard mapping is awkward.

  > DECnet/SNA MS-DOS 3270 TE for PC nodes.

  > DECnet/SNA Ultrix 3270 TE for Ultrix nodes.

- DECnet/SNA VMS Printer Emulator. Makes a VAX printer directly accessible to an IBM host.

- DECnet/SNA VMS Distributed Host Command Facility. Gives an IBM 3270-class terminal access to VAX/VMS systems. Not available for VMS/SNA configuration.

Advanced Services

- DISOSS Document Exchange Facility. Allows the DEC world access to the distribution and software facilities available in DISOSS. Will pass final-form type documents.

- Message Router Gateway. Available for both SNADS and PROFS. Uses the X.400 messaging facilities to link the two environments.

- Data Transfer Facility. The Data Transfer Facility (DTF) is a new product that provides higher throughput and functionality for data access. The program includes software on the IBM side, a significant change from past strategy. DTF integrates VSAM files structures with the RMS services on the VAX.

  > On the DEC side, you use DCL commands (Copy, Dir, etc.) to access the IBM files. Supports RMS sequential, relative or indexed files, with fixed or variable length.

  > On the IBM side, you use ISPF or TSO commands to access the DEC files. Supports physical sequential data set organization with fixed or variable length.

Programmatic Interfaces

- DECnet/SNA VMS APPC/LU6.2 Programming Interface. Provides the library function to allow you to develop program to program communication between two applications; one of which is on the VAX, the other on the IBM.

- DECnet/SNA VMS 3270 Data Stream Programming Interface (DSPI). The DSPI gives support for LU Type 2 programming. This is used when the program on the VAX essentially emulates a 3270 terminal. The 3270 terminal emulator is built on top of this library.

- DECnet/SNA VMS Application Programming Interface (API). The API is a library that supports the LU Type 0. The LU0 interface gives very low level access to SNA functions. An example of an access routine built on the API library is the Data Transfer Facility.

Data Transfer Facility V2.0

- The Data Transfer Facility (DTF) is a new product that provides higher throughput and functionality for data access. The program includes software on the IBM side, a significant change from past strategy. DTF integrates VSAM files structures with the RMS services on the VAX.

- VMS users can use the Digital Command Language or the Record Management Services to access IBM-based data systems. The software on the IBM system is an implementation of the File Access Listener.

- Example:

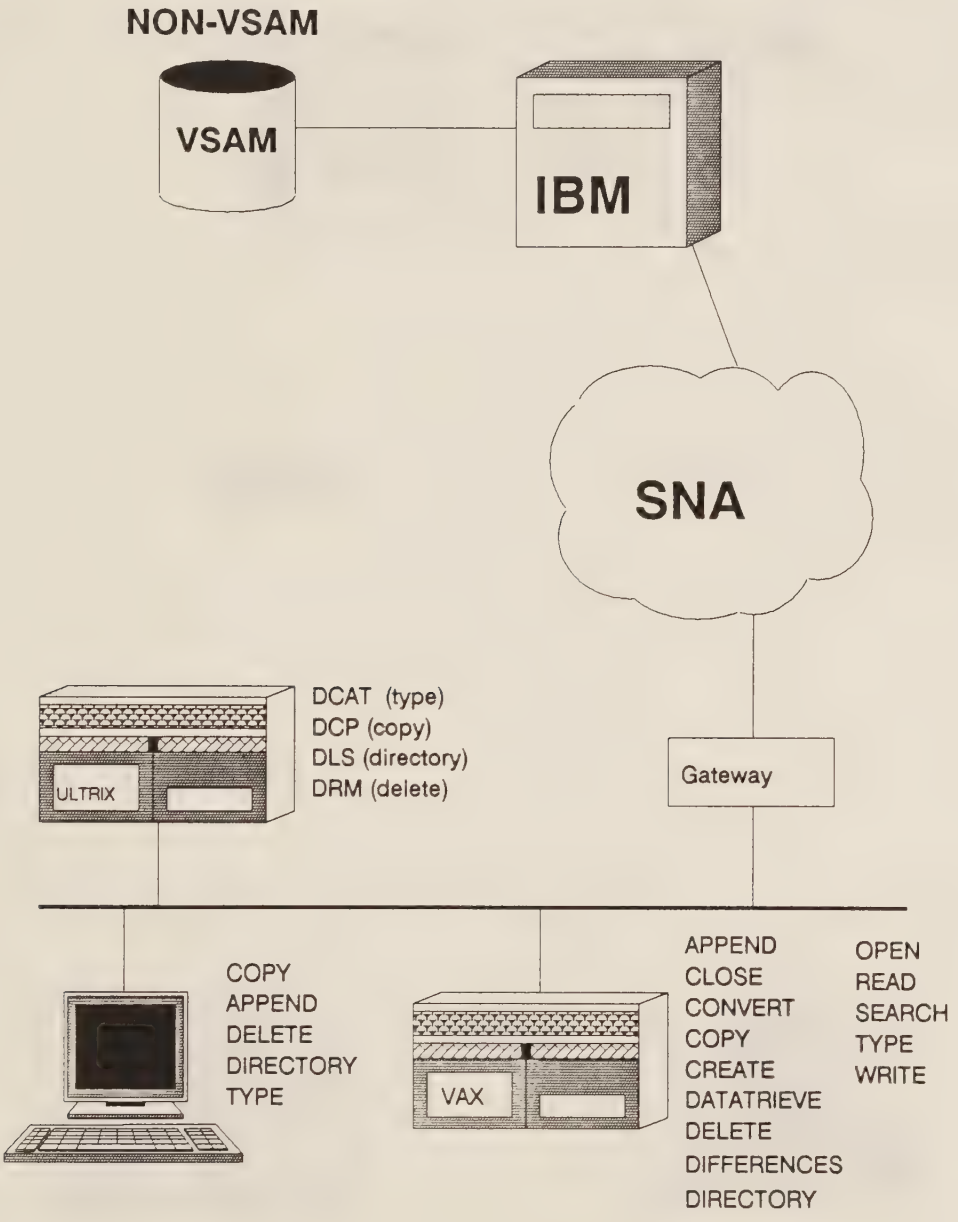
```
COPY FILE.DAT GATE"SNADTF"::"JONES.DATA.DAT/VSAM"
```

- The DTF facility checks a proxy login database for login information to the IBM system. The data access then proceeds in the authorization context of the IBM user.

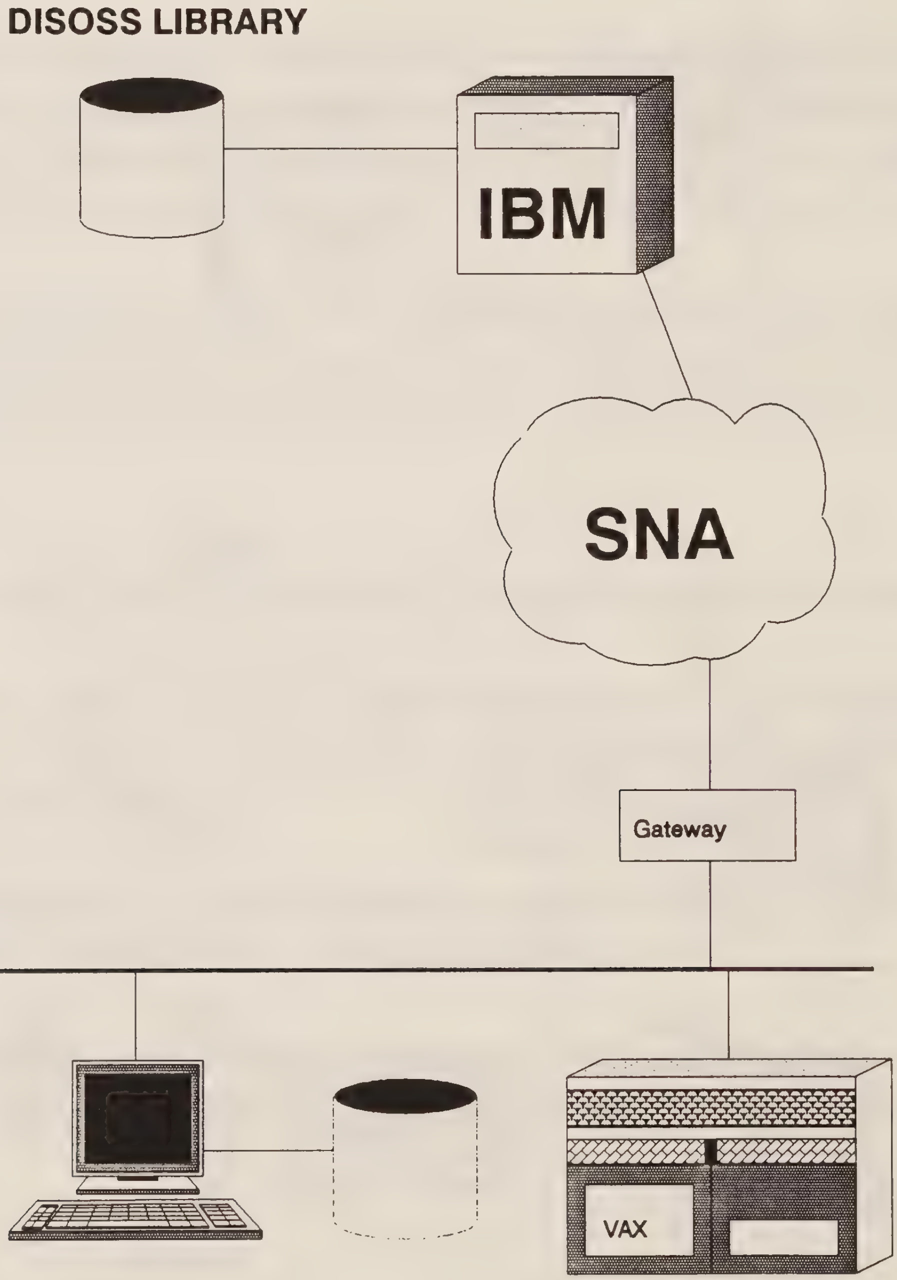
- Most DCL commands work on IBM objects, including OPEN, CLOSE, COPY, CREATE, DIRECTORY, SEARCH, TYPE, etc..

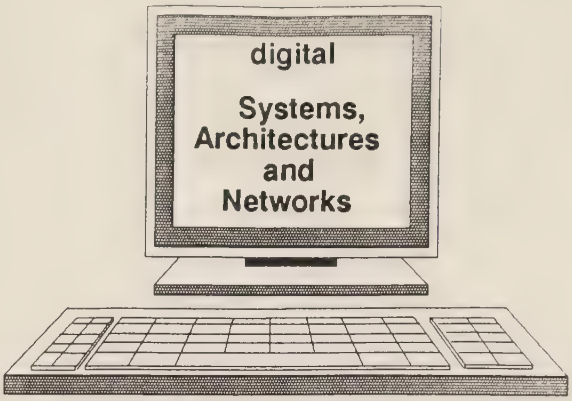
- Allows bidirectional file transfer between: VMS - MVS nodes, DECnet-DOS and MVS nodes, DECnet-ULTRIX - MVS nodes, AND MVS - MVS nodes.

Integration of File Systems

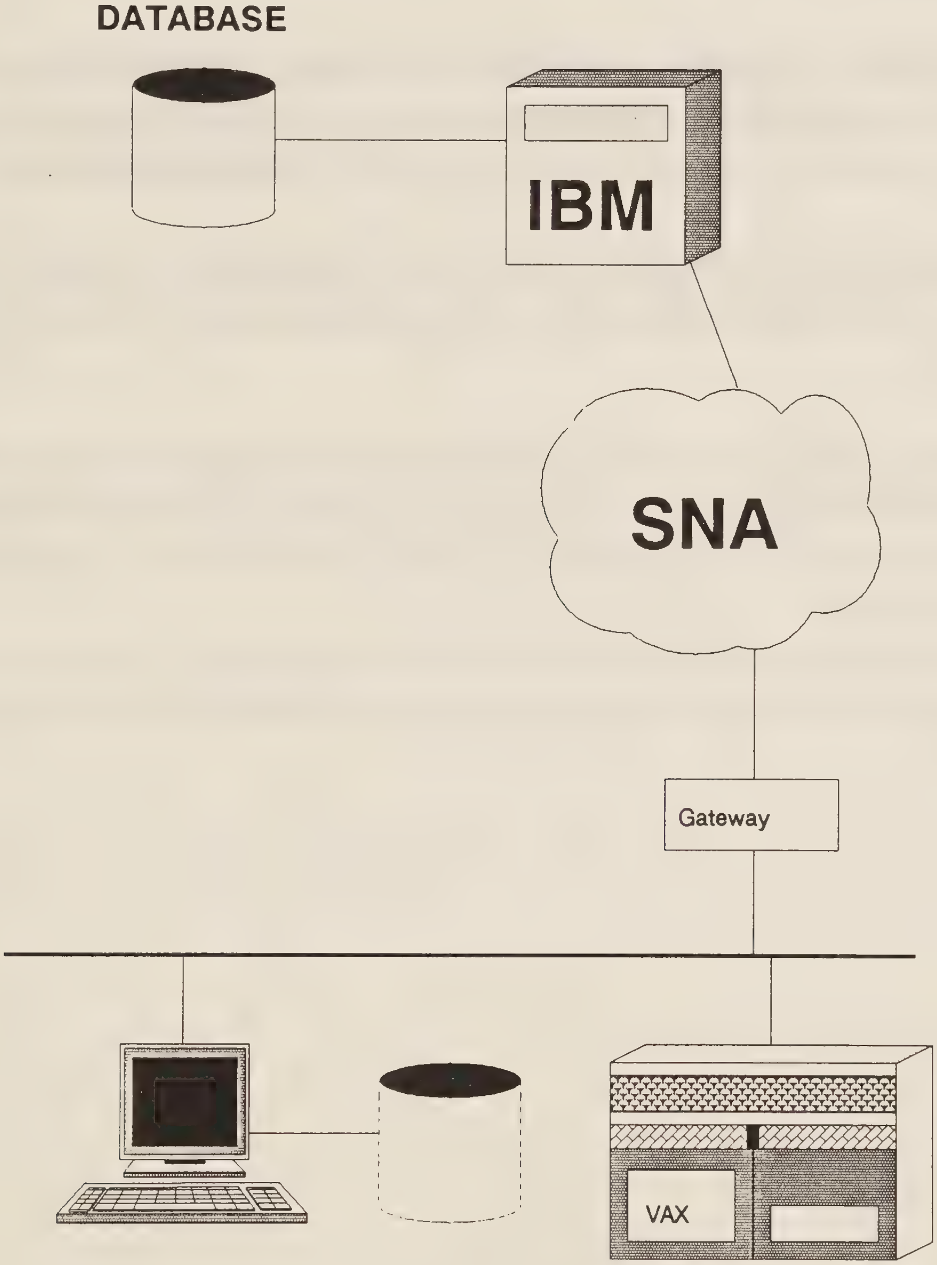


Integration of Office Systems





Integration of Database Systems



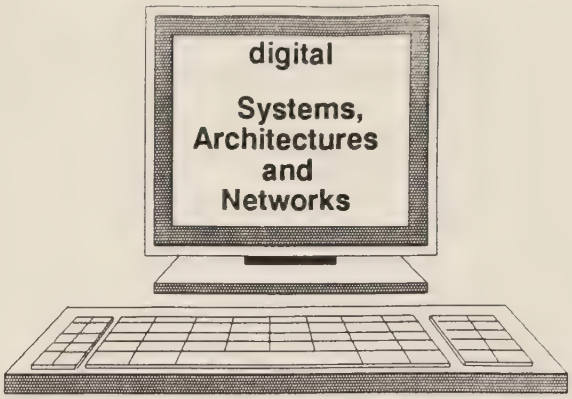
Alternatives to Gateways

- Gateway systems are not necessarily the most cost-effective method of providing interconnection. If the primary application is terminal access to dual environments, a data switch may be more appropriate.

- Some companies, such as Infotron, make terminals that have both a COAX and an RS-232 outlet, allowing simultaneous connection to both environments.

- Products from groups like Gandalf and Micom feature data switches. Many switches have built in protocol converters. An alternative to protocol conversion is to put asynchronous terminal support on IBM cluster controllers.

SYSTEMS NETWORK ARCHITECTURE



Key Concepts in This Section

- Basic services include terminal emulation, printer emulation and RJE emulation. This basic functionality can also be found in more basic products than a full-fledged SNA gateway.

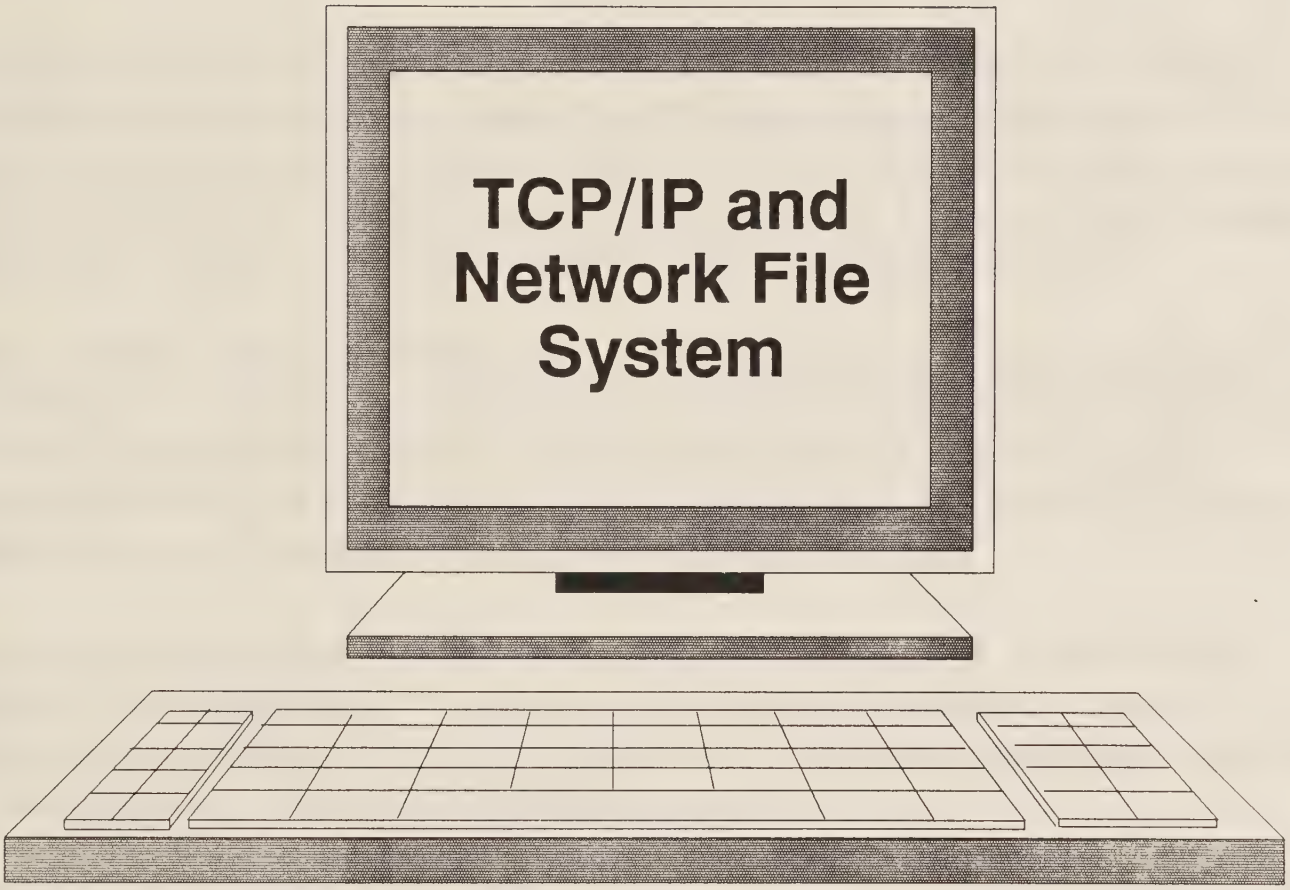
- Advanced Program to Program Communication (APPC) provides the foundation for advanced services. These include data transfer facilities such as EDE.

- DEC products work on dedicated gateways or on a portion of a VAX. The gateway can be expected to be transferred over to a MicroVAX architecture.

- Alternatives to DEC products include simple protocol converters and data switches and high performance solutions such as the Interlink gateway.

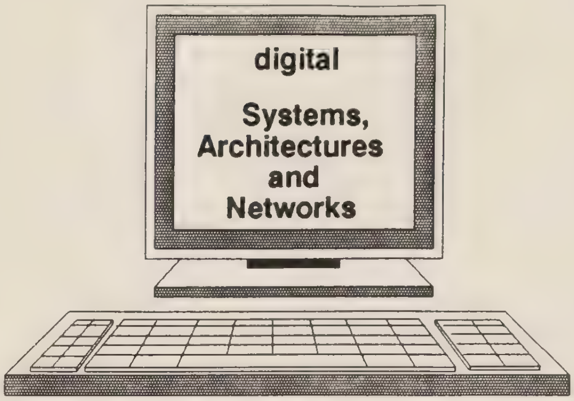
"If you're going to sin, sin against God, not the bureaucracy. God will forgive you but the bureaucracy won't."

Hyman G. Rickover



TCP/IP and Network File System

TCP/IP AND NETWORK FILE SYSTEM



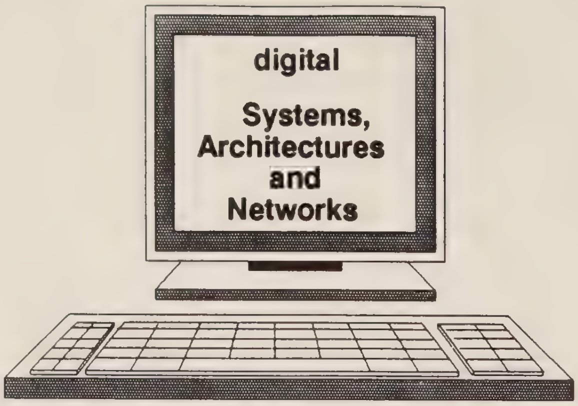
Overview

- TCP/IP is an alternate set of protocols to DECnet. All of the nodes pictured here could have used the DECnet protocols. Because TCP/IP is non-proprietary, many vendors support this form of networking on their equipment. Many vendors have adopted TCP/IP as a standard because it assures them of the ability to build a heterogeneous network.

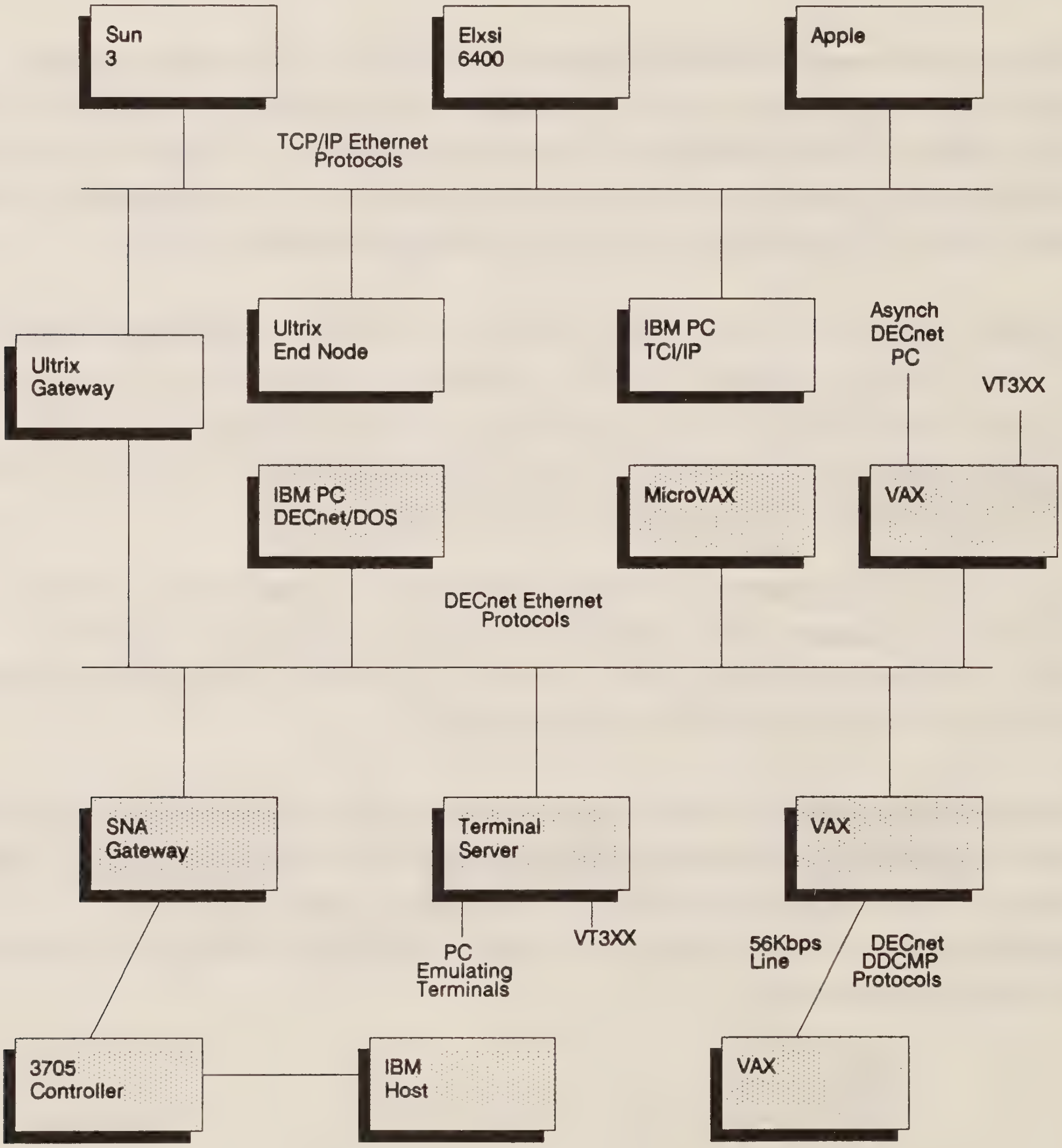
- The newest version of Ultrix (Version 3.2) includes a gateway between TCP/IP and DECnet. Access to files, terminal sessions and mail transfer can be accomplished from both networks without regard to which network the target node is on. This permits users to have two different networks and a seamless interconnection of the two.

- Several companies such as Bridge/3Com and Micom make TCP/IP based LAN equipment. This includes bridges, repeaters, routers, gateways, terminal servers, print servers and other equipment similar to that covered in the DECnet/Ethernet section.

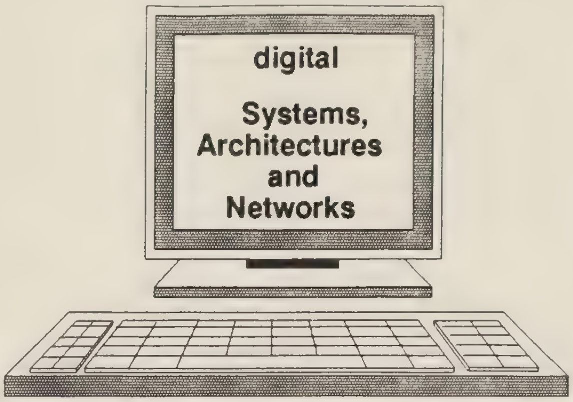
- The Network File System (NFS) is a set of enhancements developed by Sun Microsystems and licensed to over 250 other vendors. NFS adds a new level of functionality to TCP/IP, including interprocess communications, a distributed file system and the ability to boot diskless nodes over the network.



Integration of Unix Equipment



TCP/IP AND NETWORK FILE SYSTEM



TCP/IP

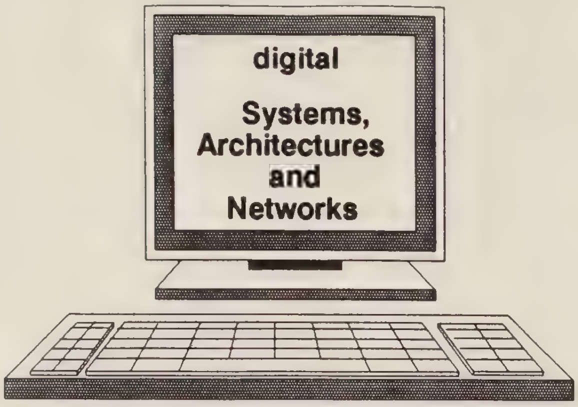
- TCP stands for Transmission Control Protocol. IP stands for Internet Protocol.

- Developed with support from the Defense Advanced Research Projects Agency (DARPA). The first experimental TCP implementations were at Stanford University and at BBN Communications.

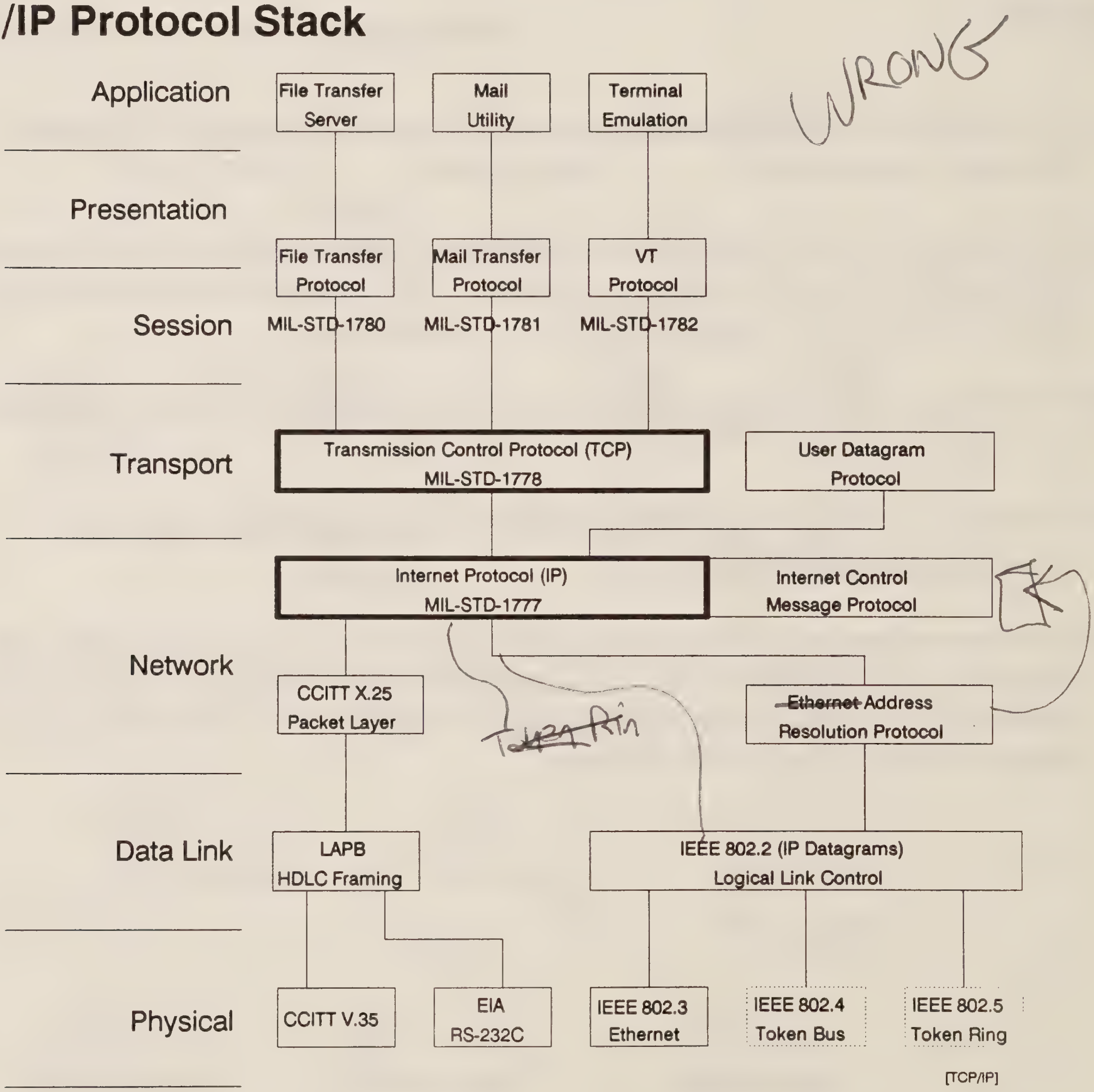
- TCP/IP is the official DoD standard communications protocol. It is used on Arpanet and on the Defense Data Network.

- TCP/IP is a standard part of the 4.2BSD release of Unix. Most Unix networks are TCP/IP nets.

- TCP/IP is layers 3-4 of the ISO model and typically runs on an Ethernet. There are also several upper layer features that have been developed at Berkeley. The upper layer features developed by Sun Microsystems are known as the Network File System.



TCP/IP Protocol Stack



[TCP/IP]

Function of TCP/IP

- IP is a layer 3 protocol used to route packets over the network. IP forms the basis for the connectionless network service (CLNS) in the OSI protocol stack.

- TCP is a layer 4 protocol used for highly reliable, end to end transport. In addition to TCP, most systems support the connectionless User Datagram Protocol (UDP) for unacknowledged information.

- The Internet Control Message Protocol is an error event logger.

- Standard Unix (ARPANET) upper level services include:

  > rlogin (TELNET) - log into a foreign node

  > rcp (FTP) - remote copy using the file transfer protocol

  > mail (SMTP) - simple mail transfer protocol

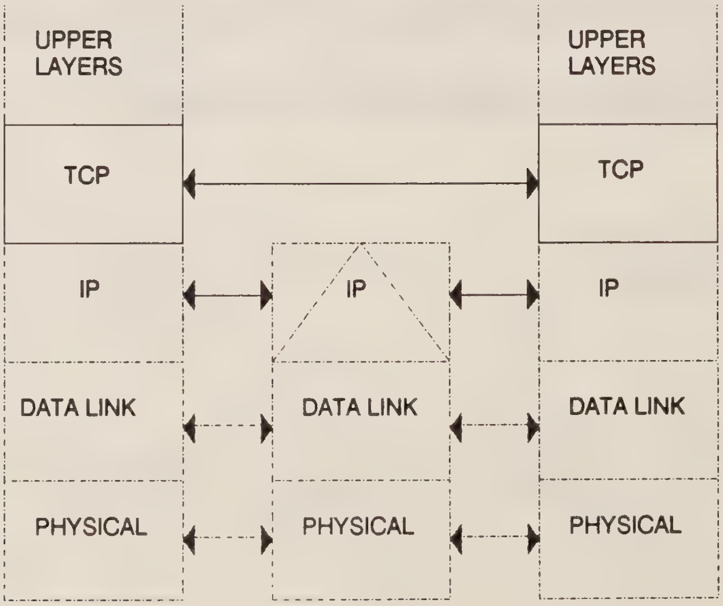
DEC and TCP/IP

- Ultrix has TCP/IP support as a standard part of their operating system. Since TCP/IP operates at layers 3-4, you can use any DEC-supported Ethernet controller, even if it also being used for DNA or LAT traffic.

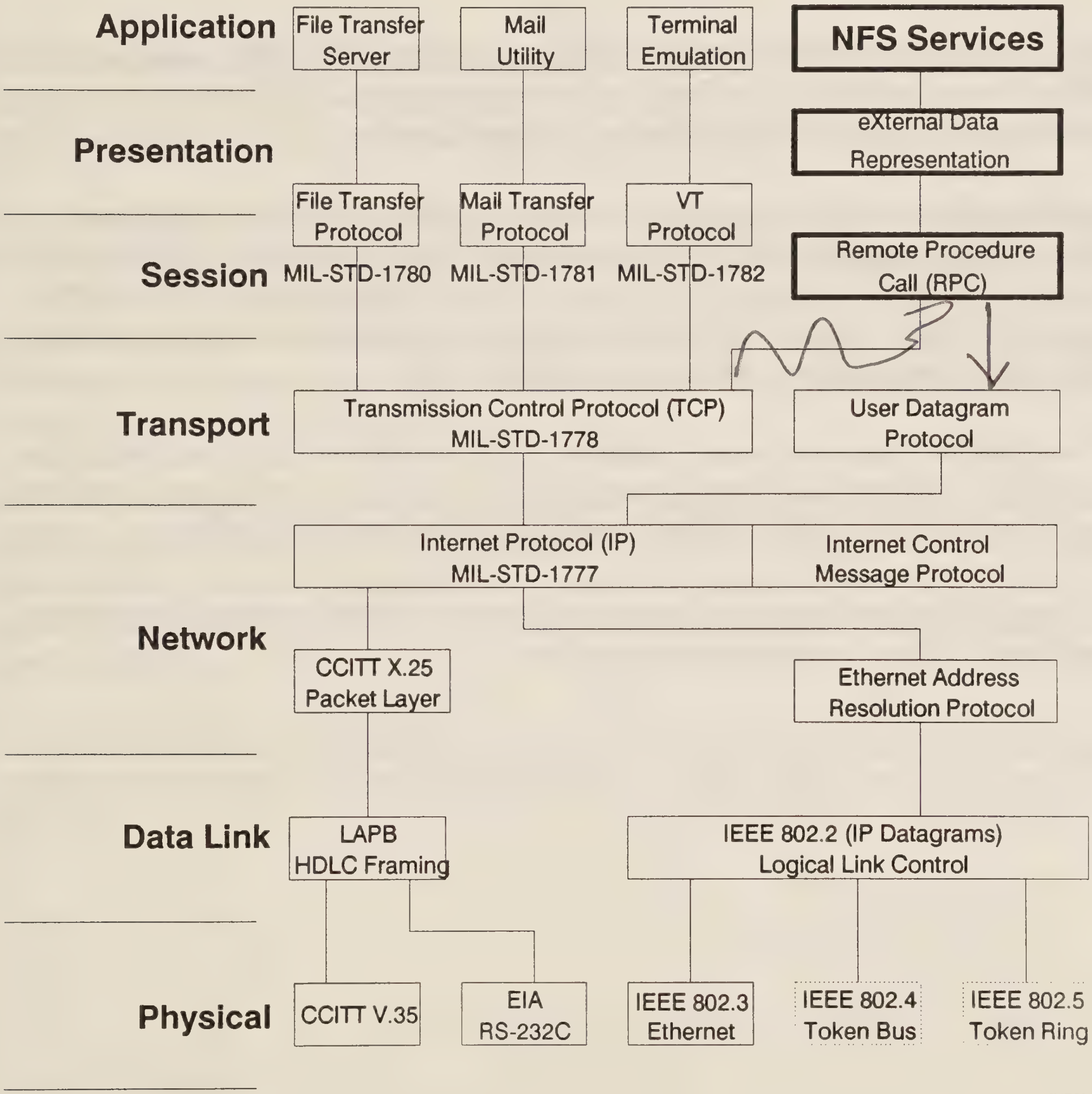
- DEC OEMs a product developed by the Wollongong Group called IP/TCP. IP/TCP allows a VMS node to participate in a TCP/IP based network.

- This solution allows both TCP/IP and DECnet to reside on a single machine.

- The software will also work on Arpanet and the Defense Data Network (DDN).



Network File System (NFS)



Application
File Transfer Server
Mail Utility
Terminal Emulation
NFS Services

Presentation
eXternal Data Representation

Session
File Transfer Protocol MIL-STD-1780
Mail Transfer Protocol MIL-STD-1781
VT Protocol MIL-STD-1782
Remote Procedure Call (RPC)

Transport
Transmission Control Protocol (TCP) MIL-STD-1778
User Datagram Protocol

Network
Internet Protocol (IP) MIL-STD-1777
Internet Control Message Protocol
CCITT X.25 Packet Layer
Ethernet Address Resolution Protocol

Data Link
LAPB HDLC Framing
IEEE 802.2 (IP Datagrams) Logical Link Control

Physical
CCITT V.35
EIA RS-232C
IEEE 802.3 Ethernet
IEEE 802.4 Token Bus
IEEE 802.5 Token Ring

[NFS]

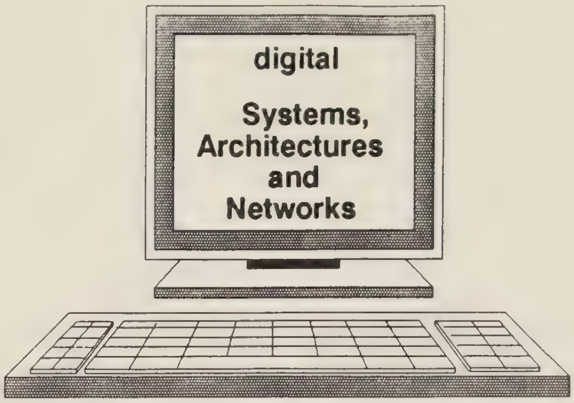
NFS: Layers 5 and 6

- Sun Microsystems has implemented a variety of TCP/IP based services which have become a de facto industry standard. NFS forms a client/server relationship between network nodes.

- Remote Procedure Call (RPC) is a layer 5 (Session layer) protocol allowing two nodes to have interprocess communications. RPC works by registering and assigning a number to a set of procedure calls, either permanently or dynamically. For example, the system called rnusers() returns the number of users on a foreign node.

- The eXternal Data Representation is a presentation layer protocol that specifies a machine independent way to represent information. XDR is implemented as a filter for the particular machine on which it is running.

- Typical XDR data types are integers, floating point, strings, structures and most other C supported variables.



NFS: Layer 7 Services

- The Network File System is a catch phrase for XDR, RPC and a variety of application layer (layer 7) services. They were developed by Sun Microsystems and can be licensed free of charge.

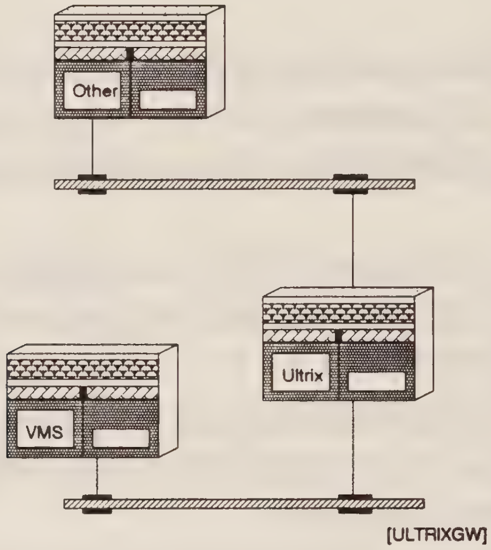
- Over 250 vendors have licensed NFS. Versions exist for PCs (as a client only) and VMS VAXes. NFS is a standard part of Ultrix Version 3.2.

- The NFS MOUNT command allows you to mount a foreign file system as if it were local. When you type $ dir on a VMS VAX, you can see files that reside on a Unix or Ultrix machine.

- The Yellow Pages is a simple, distributed database across a network. It is typically used to maintain one copy of a password file, then move that out to other nodes on the network. Yellow Pages can also be used to publish the availability and content of resources, changes in network configurations.

- Other NFS applications being released include a Network Lock Manager, a Time Synchronizer, a Distributed Name Service and a Network Mail Service.

Ultrix Gateways



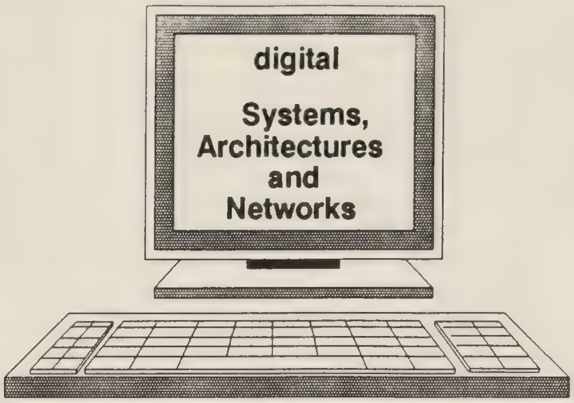
- It is possible for an Ultrix node to participate in both DECnet and TCP/IP environments. By logging on from the VMS node, all the services of the TCP/IP environment are available. DECnet makes you look like you're locally connected to the Ultrix node (using the Virtual Terminal Service), then the TCP/IP services are used to perform a rlogin to the Ultrix node.

- The Ultrix gateway removes the step of logging into the intermediate Ultrix node and passes the request transparently to the target node. The Ultrix gateway works for three types of services:

  > Mail (SMTP)

  > virtual terminal (TELNET)

  > file transfer (FTP) <file level access only>



Typical TCP/IP Products

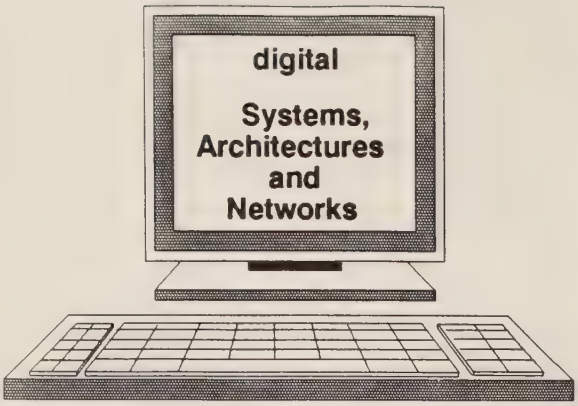
- Several vendors provide TCP/IP based equipment such as terminal servers, bridges, gateways and routers. Bridge Communications, Micom and Ungermann Bass are but a few.

- Bridge communications products will be used to give specific examples. Bridge terminal servers have from 2-64 ports and work on baseband, broadband, fiber and other media. Versions exist that are fault tolerant.

- The IB/2 is a protocol independent bridge. It forwards packets using a learning algorithm.

- The Bridge GS/3 is used as a protocol dependent internet router. It is TCP/IP dependent. The GS/3 has four synchronous data lines with data rates up to 56 Kbits/s.

- A variety of network management devices are available. A PC based system can collect data for further analysis and provide a user interface for configuring and managing terminal servers and other devices. A SUN Workstation based system provides a very fancy graphical interface, plus increased storage capacity for incoming data.



TCP/IP AND NETWORK FILE SYSTEM

Key Concepts in This Section

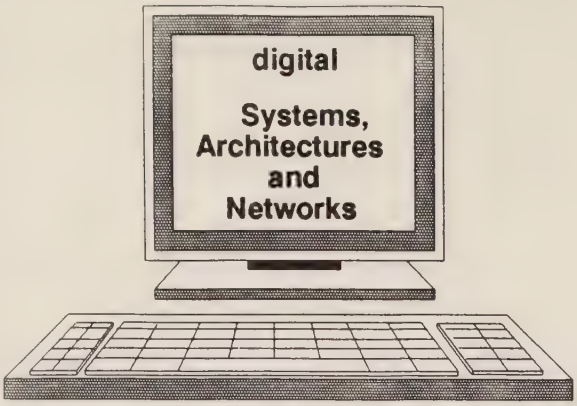
- The Network File System together with TCP/IP provides a viable alternative to DECnet. This solution is especially appropriate in the Unix based network environments and at sites with many different kinds of hardware.

- The Network File System allows you to mount a remote file system on a local node. A PC, acting as a client node, can mount a VMS file as the "E:" drive and a SUN file as the "F:" drive. A Sun diskless node can mount its operating system from a remote VAX running Ultrix.

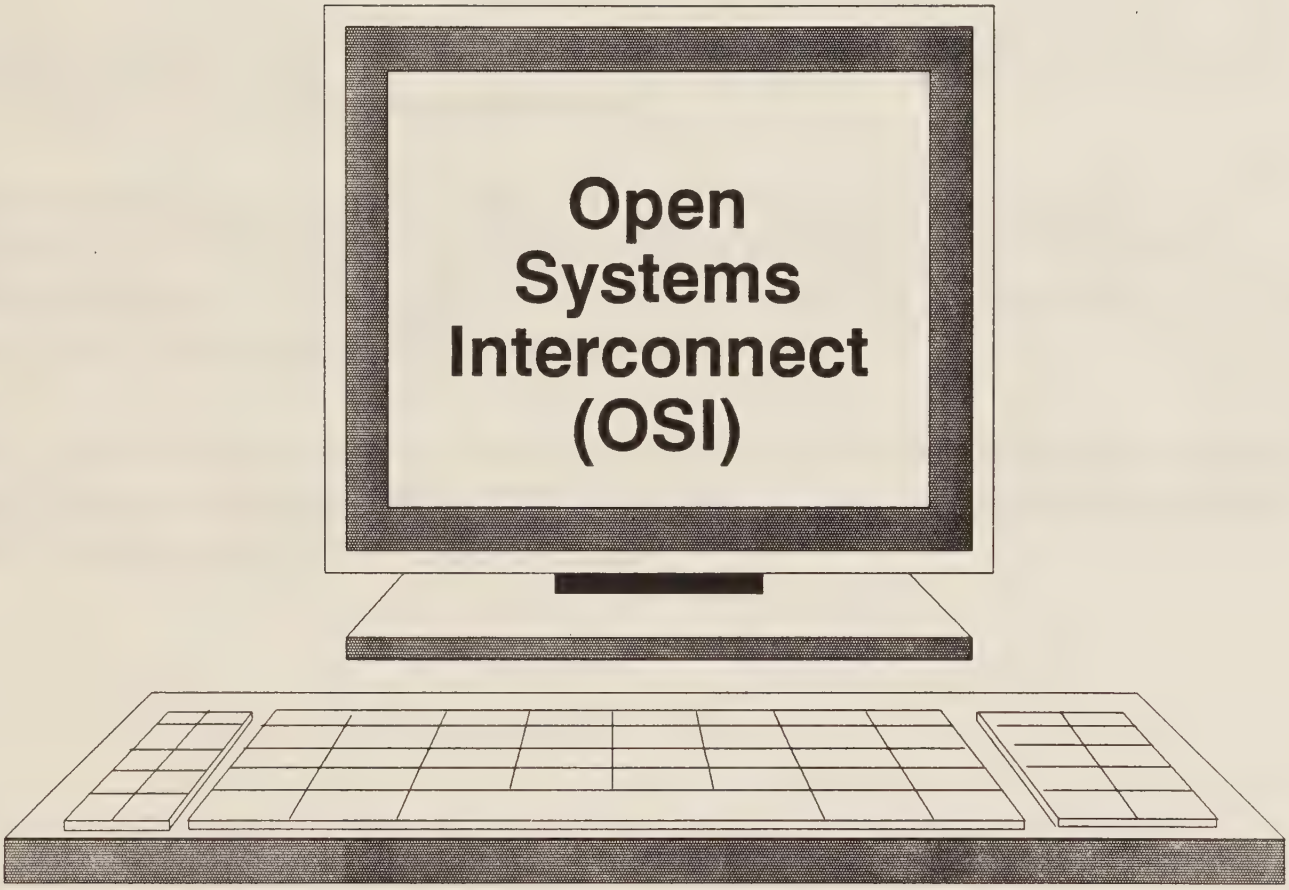
- The key to NFS are the RPC and XDR layers services. These provide a transparent method of representing data and executing procedures that are machine and operating system independent.

- Numerous products such as terminal servers, bridges, routers and gateways are available in this networking environment.

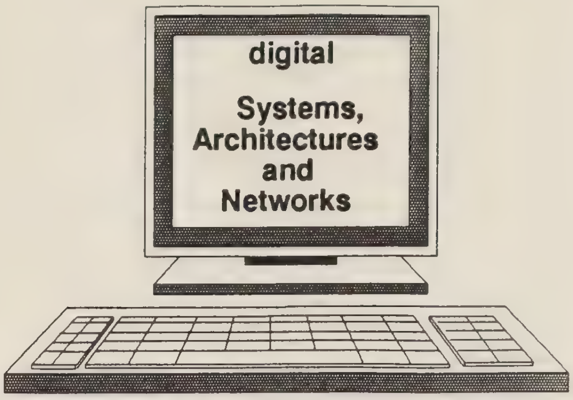
> "Please be good enough to put your conclusions and recommendations on one sheet of paper in the very beginning of your report, so I can even consider reading it."
>
> *Winston Churchill*



TCP/IP AND NETWORK FILE SYSTEM


Open
Systems
Interconnect
(OSI)

DNA PHASE V AND OSI



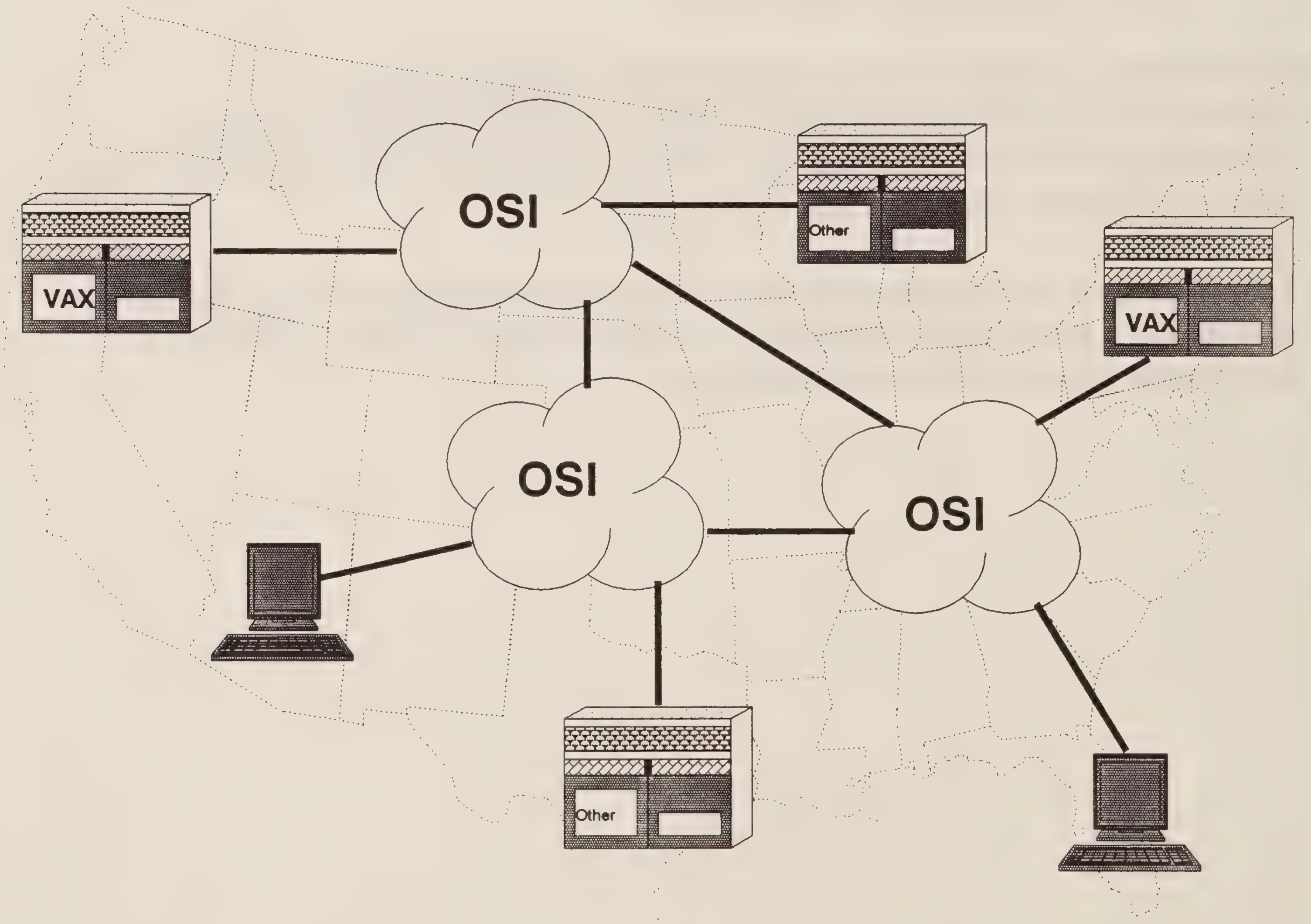
Overview

- Catchword for a set of standards including ISDN, CCITT X.400, MAP, TOP and ISO's efforts on standards.

- OSI involves cooperative efforts between industry, users and government. Defined in an open fashion to build on top of existing technologies. For example, X.25, Ethernet (802.3), Token Ring and Token Bus are integral parts of OSI standards.

- OSI Services are nearing the final stage of definition. OSI has become particularly important with DEC's announcement of DECnet Phase V which will be an OSI implementation.

OSI Networks



ISO/OSI Reference Model

Application	Provides all services directly comprehensible to applications programs.
Presentation	Negotiates data transfer to and from standardized formats.
Session	Synchronizes and manages user dialogues.
Transport	Provides a reliable end to end data transfer.
Network	Performs message routing between nodes.
Data Link	Detects transmission related message errors.
Physical	The physical media and the electrically encoded messages.

DECnet/OSI Phase V

- Phase V of DECnet is an implementation of the OSI protocols.
  - > Support for HDLC (High Level Data Link Control).
  - > Network layer enhancements. Will have a 20 byte address space - support 100,000 to 1 million nodes.— 10^{48}
  - > Support OSI Transport Protocol.
  - > Better Network Management.
- Phase V of DECnet is expected to be available publicly by the end of 1991. By the end of 1990, DEC expects to have their 50,000 internal nodes connected to Phase V.
- Phase V remains n-1 compatible (i.e. Phase IV and V networks can coexist). Towers of protocol stacks allow upper layer Phase IV applications to run on top of OSI network services.
- DEC has identified OSI as one of the four key environments in which to operate. The others are SNA, TCP/IP and DNA.
- Between now and 1990, DEC will announce a series of Phase V products. The distributed naming service, and session and transport layer services are currently available. Components of the lower layer services are already in place.

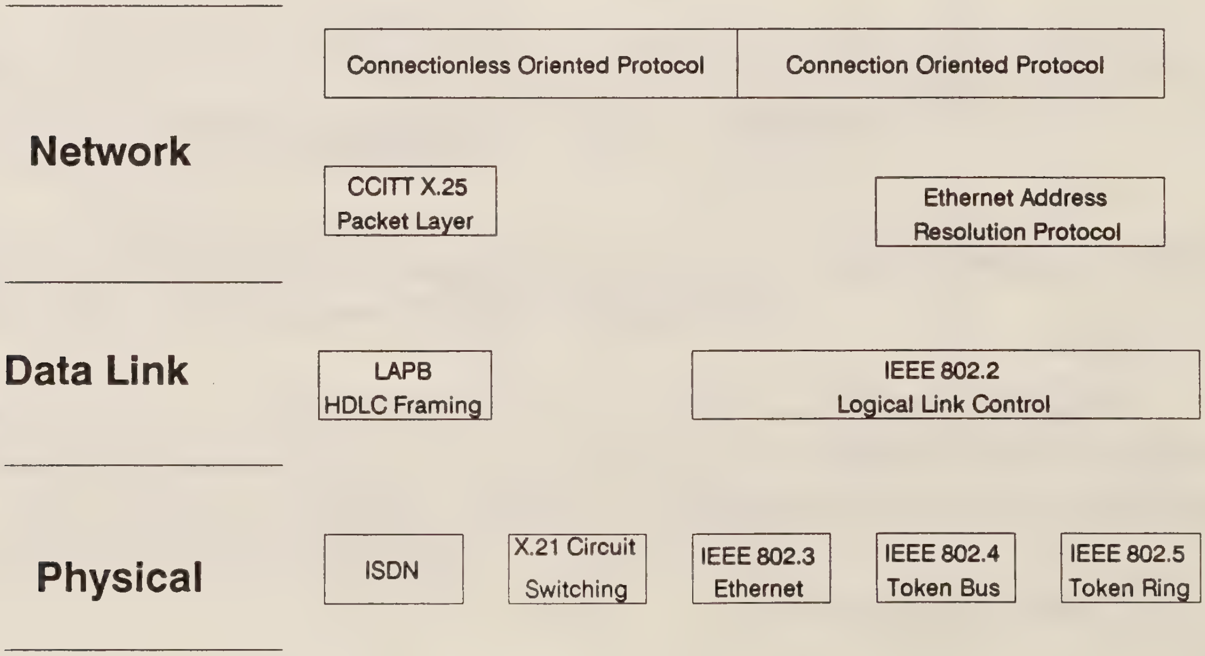
Evolution of DNA to OSI

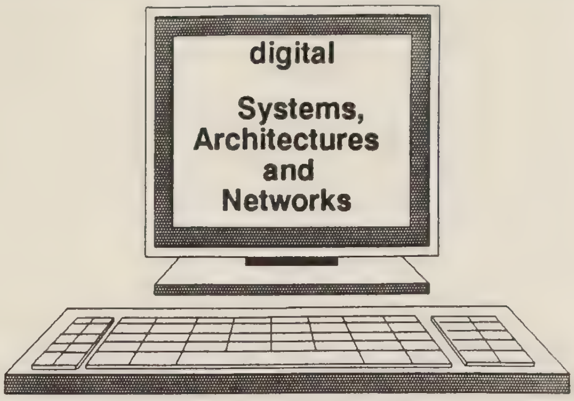
	OSI Layers	DECnet Phase IV Layers	OSI Products	DECnet/OSI Phase V Functions	
7	Application	User Network Mgmt.	OSI file transfer (FTAM) Electronic mail (X.400)	Networked office systems Videotex Electronic mail Computer conferencing Remote database File transfer Virtual Terminal Network Mgmt. SNA interconnection DECnet system services Others	OSI FTAM CCITT X.400 Others
6	Presentation	Network Application	OSI applications kernel (OSAK)		OSI presentation
5	Session	DECnet session control		DECnet session control	OSI session
4	Transport	DECnet transfer (NSP)	VAX OSI transport (VOTS)	Common transport interface DECnet transport (NSP)	OSI transport
3	Network	DECnet routing (Adaptive routing)		ISO connectionless service ISO connection-oriented service (over X.25) ISO ES-IS routing protocol IS-IS routing protocol	
2	Data link	Data link	X.25 OSI-standard Ethernet	DDCMP X.25 OSI-standard Ethernet HDLC	
1	Physical	Physical link			

*Source: Digital Equipment Corporation

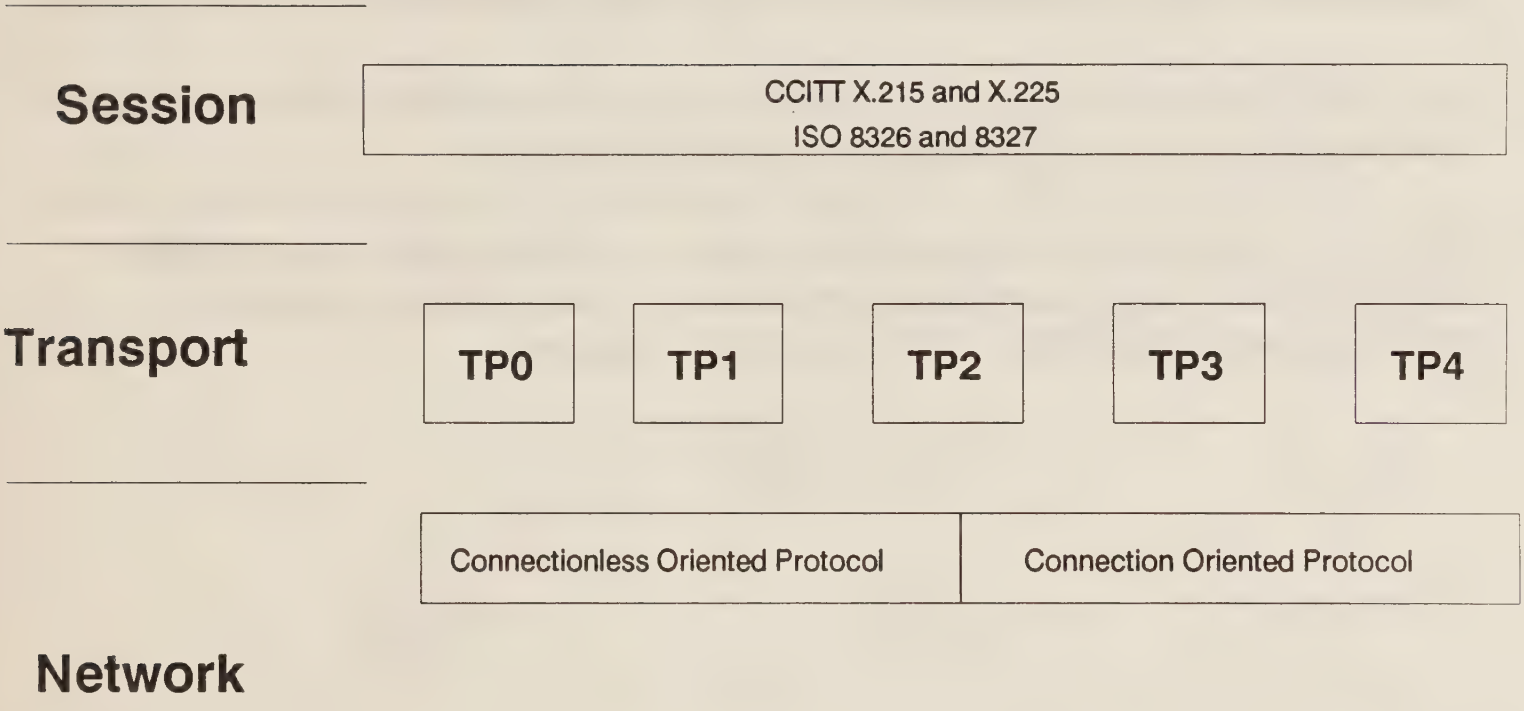
Lower Layer Services

- The lower layer of OSI supports a wide range of existing technologies.
- The functions available at the various layers have become somewhat blurred due to the incorporation of existing technologies. For example, X.25 provides a data link type of service, but gives reliable transport of data in a connection mode. Ethernet, on the other hand, provides a datagram service with best effort delivery and no error recovery.
- Convergence functions allow the various technologies to combine into one set of services that become available to the network user. The network layer can be used by the transport layer in either a connection oriented or connectionless mode.





OSI Layers 4 and 5



Session

CCITT X.215 and X.225
ISO 8326 and 8327

Transport

TP0 **TP1** **TP2** **TP3** **TP4**

Connectionless Oriented Protocol | Connection Oriented Protocol

Network

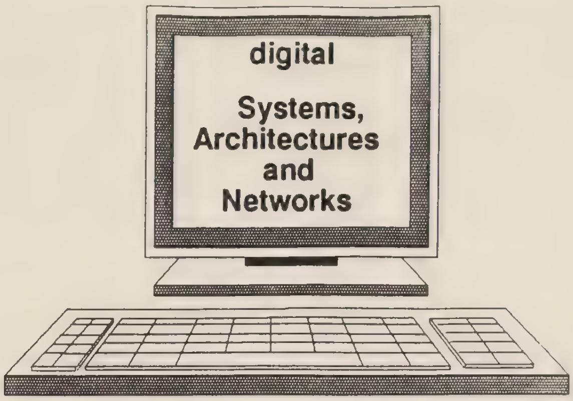
Transport and Session Layers

- The Transport Service includes five classes of operation. DEC supports TP0 and TP2 for connection to heterogeneous environments and TP4 for a reliable delivery mechanism with DNA environment

- VAX OSI Transport Service (VOTS) provides the fourth layer of OSI. It operates on a 802.3 Ethernet or over X.25 using VAX PSI.

- VAX OSI Applications Kernel (OSAK) implements the OSI session layer. It requires the use of VOTS for the transport service.

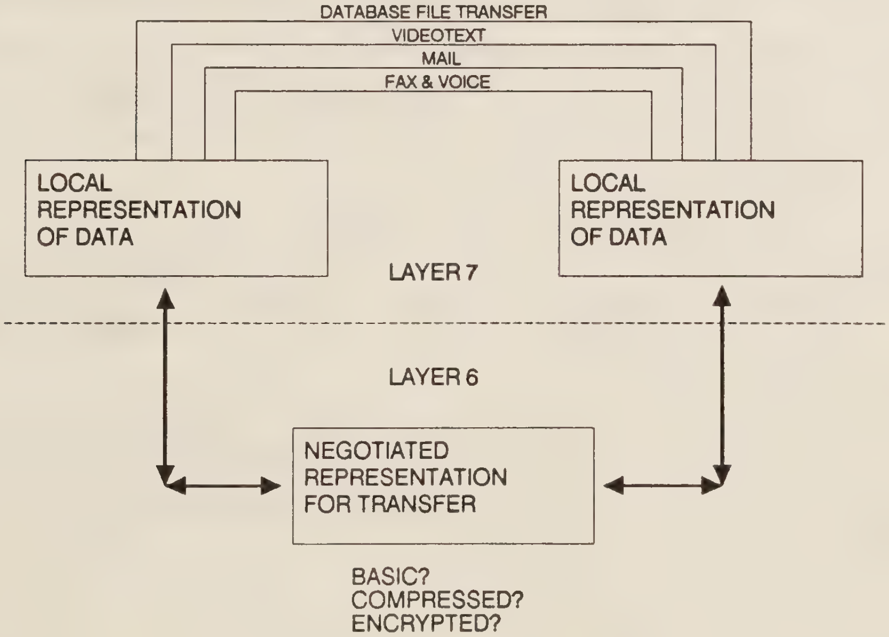
- OSAK is a set of library routines that allow users to build presentation and application layer services. Provides the foundation for specific products, including MAP, TOP, and X.400 support.



OSI Layer 6: Presentation

- The Presentation Layer is only conserned with the representation of data values for transfer. The Presentation Service is very similar to the External Data Representation discussed earlier. It translates information and data structures into a machine independent format.
- Assumes an End-to-End path.
- Possesses the Quality of Service (QoS).
- Any required multiplexing, splitting, dialogue control functions are available from lower layers.

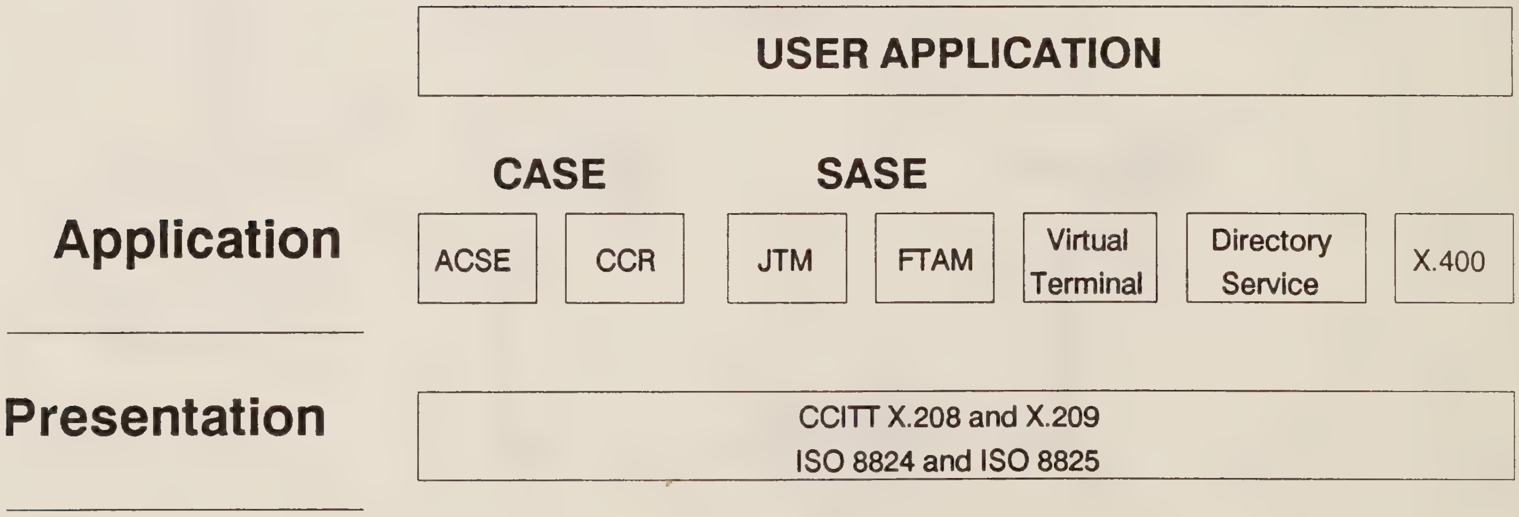
WRONG

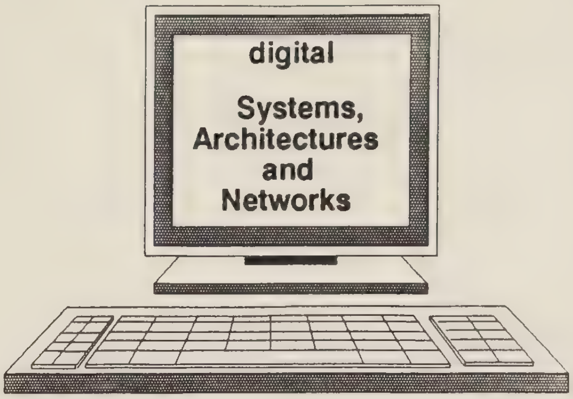

DATABASE FILE TRANSFER
VIDEOTEXT
MAIL
FAX & VOICE
LOCAL REPRESENTATION OF DATA
LOCAL REPRESENTATION OF DATA
LAYER 7
LAYER 6
NEGOTIATED REPRESENTATION FOR TRANSFER
BASIC?
COMPRESSED?
ENCRYPTED?

Local
|
Abstract
|
Transfer

OSI Layer 7: Application

- Application Level Services:
  - > Common Application Service Elements (CASE)
  - > Specific Application Service Elements (SASE)
  - > X.400 Messaging Services
  - > Manufacturing Automation Protocols (MAP)
  - > Technical Office Protocols (TOP)

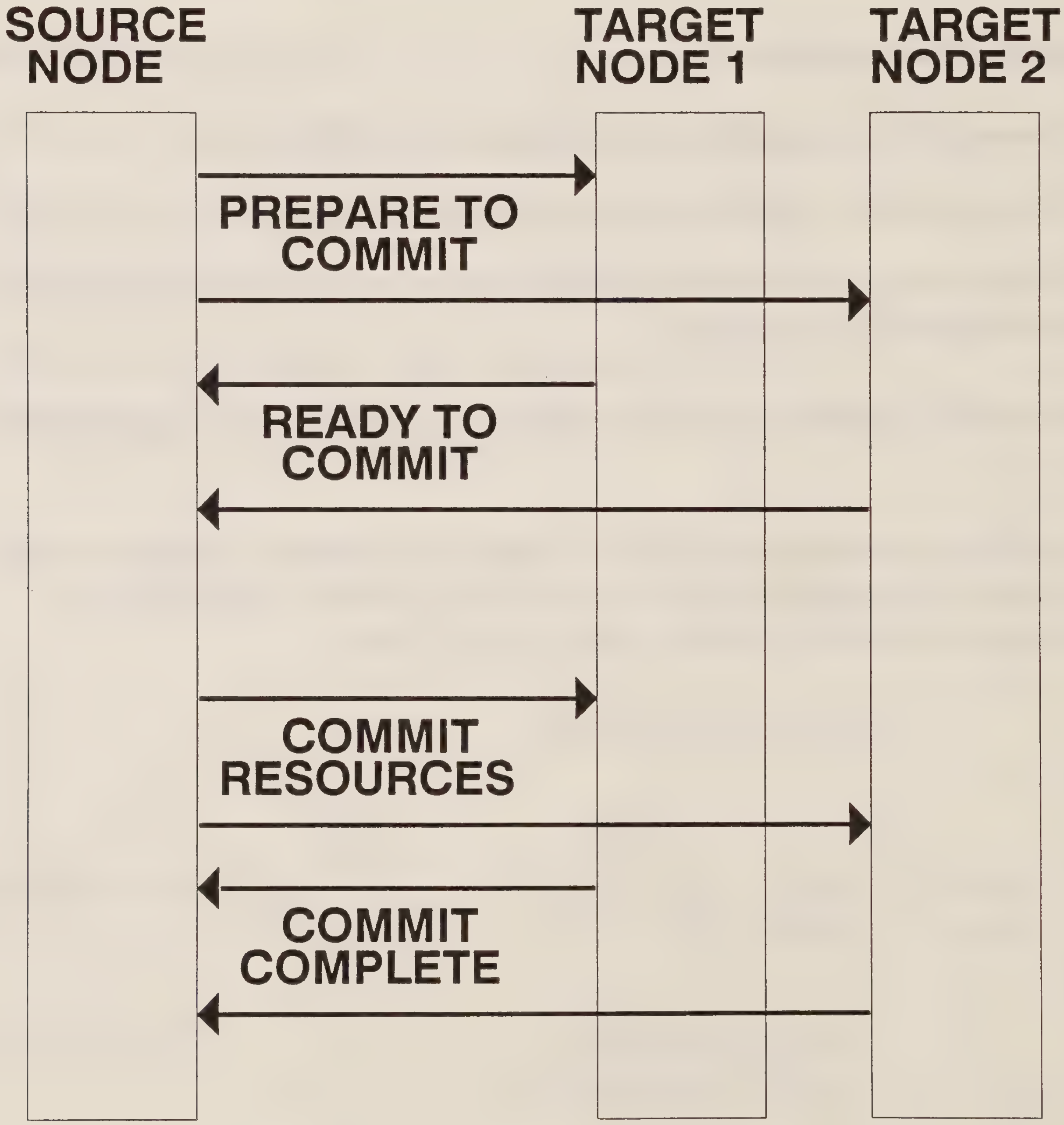




CASE Kernel

- Consists of two elements:
  - > Association Control Service Elements (ACSE)
  - > Commitment, Concurrency and Recovery (CCR)
- ACSE allows two applications' entities to form an association and to switch presentation contexts.
- Class 2 ACSE facilities will allow context switching at the application level.
- CCR facilities provide distributed transaction control, similar to the distributed database two-phase commit protocols. Use of CCR is mandatory in the JTM facility, optional in FTAM.

CCR Operation



SOURCE NODE

TARGET NODE 1

TARGET NODE 2

PREPARE TO COMMIT

READY TO COMMIT

COMMIT RESOURCES

COMMIT COMPLETE

VAX FTAM V1.1

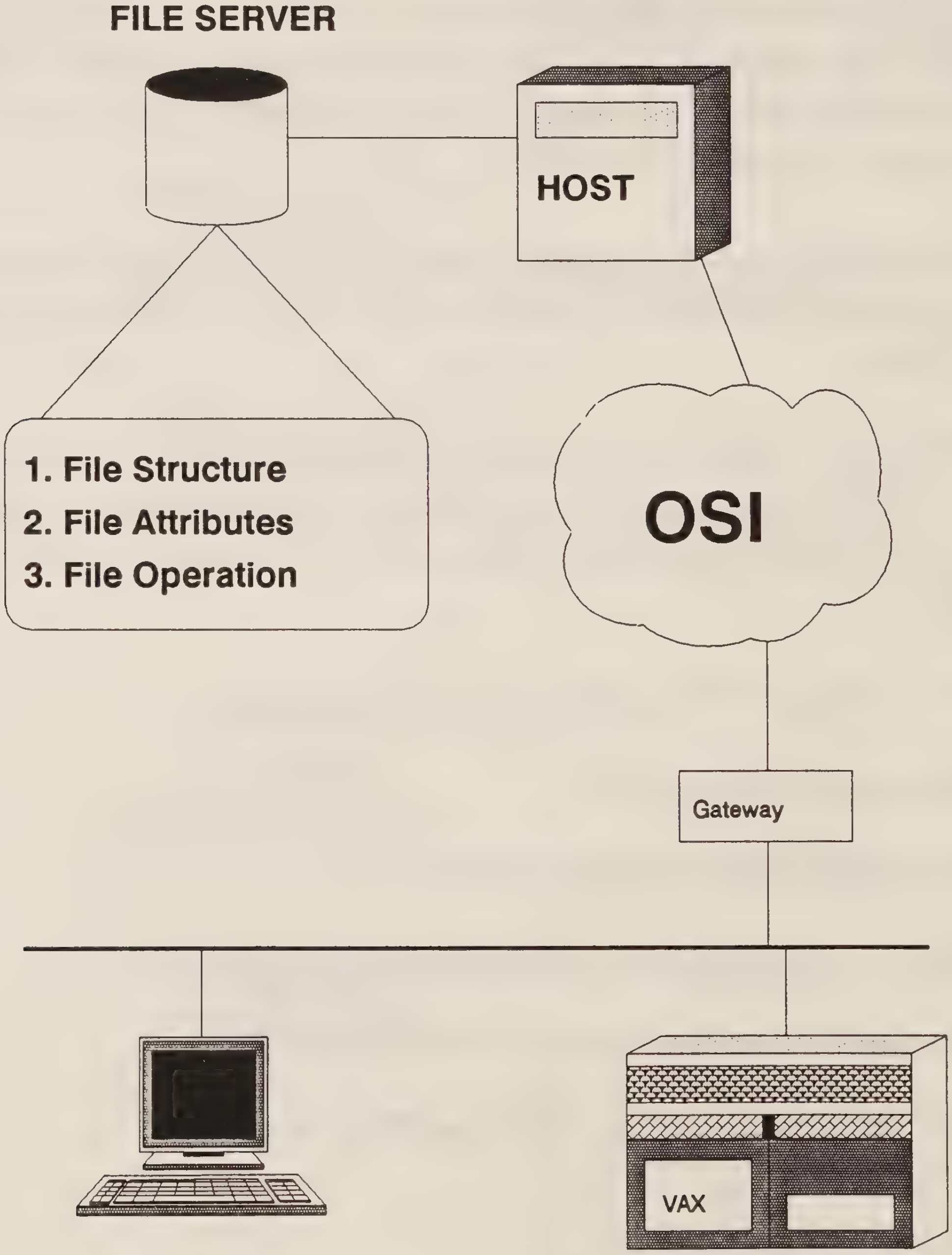
- File Transfer, Access and Management (FTAM) is a SASE that allows manipulation and transfer of stores of information. FTAM uses the concept of a virtual filestore which is mapped into the file system implemented on the target system.

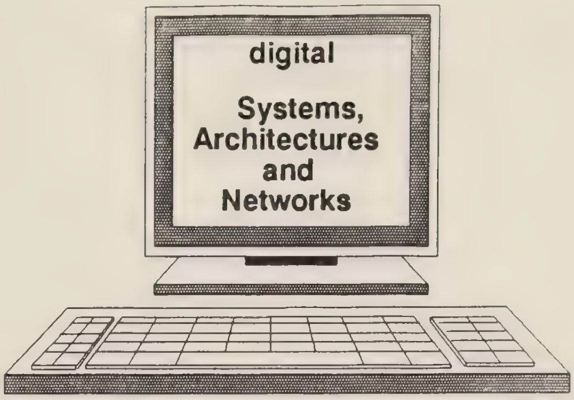
- A virtual file consists of an unambiguous filename, management properties such as the size of the file and structural properties such as length and data.

- The VAX FTAM is a VMS V5.0 layered software product that implements the ISO 8571 FTAM protocol. Using this product, you can copy files, delete files and retrieving information about files on any other ISO FTAM compliant system.

- VAX FTAM V1.1 has a DCL interface and supports:
  - > Unstructured binary files
  - > Unstructured stream format ASCII files
  - > Sequential text files with variable record format
  - > Text files with carriage return record attributes
  - > Standard RMS format for file specifications

FTAM Operation





Job Transfer and Manipulation

- JTM extends traditional RJE facilities to support extensive job control and various types of complex document structures.

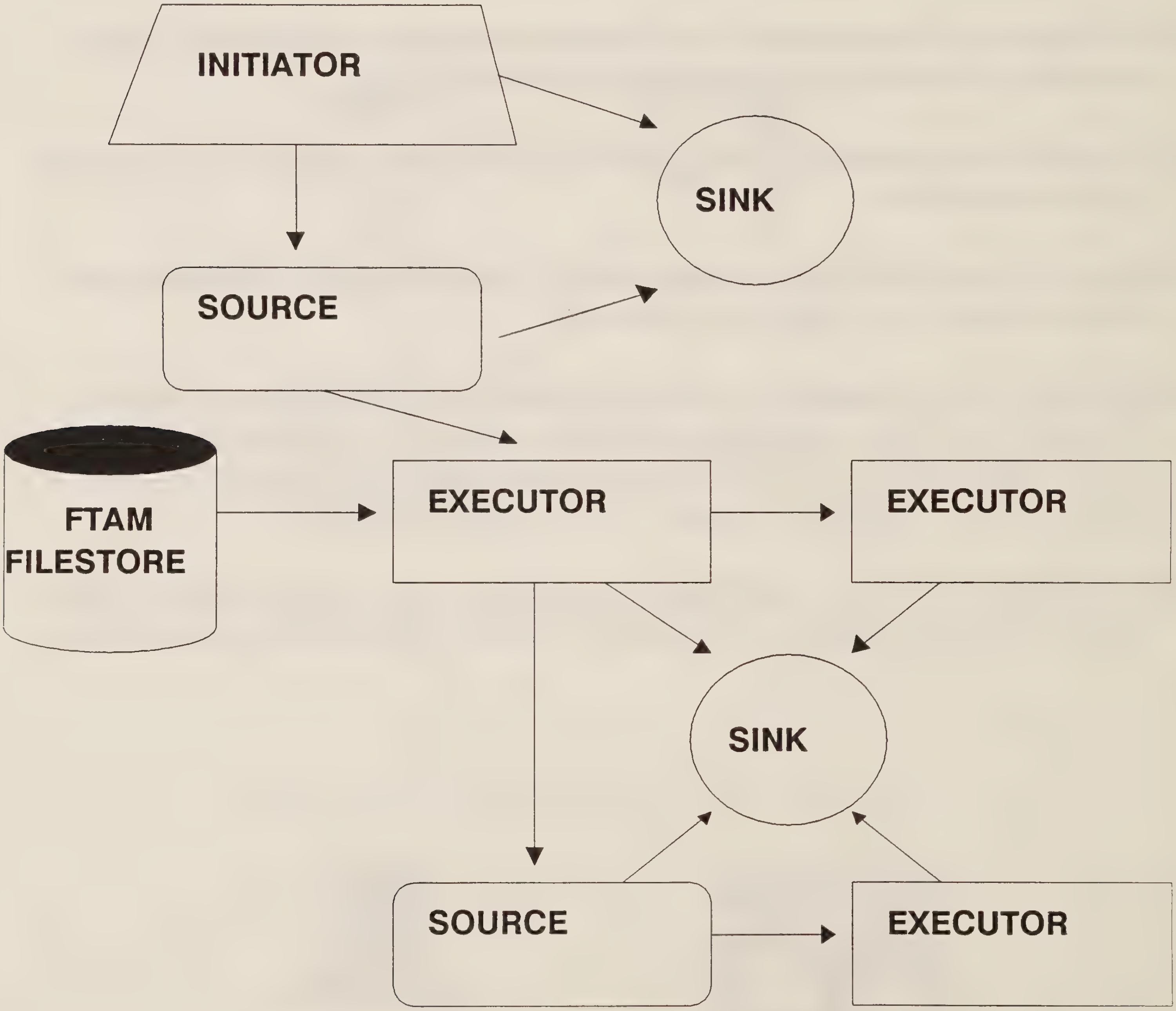
- A work order consists of work specifications and a series of documents to be operated on.

- The work specifications include security and charging information and directories on how to perform the work.

- Several kinds of nodes can all cooperate on a JTM session. Initiators, document sources, executors and sinks can all be different nodes. Document source nodes collect documents and add them to the work order. Another option is to use FTAM to access the data.

- Once jobs have been submitted, a variety of control functions allow the user to kill, stop and resume jobs as well as receive status information.

JTM Operation



INITIATOR

SINK

SOURCE

FTAM
FILESTORE

EXECUTOR

EXECUTOR

SINK

SOURCE

EXECUTOR

Virtual Terminal

- Terminals can operate in synchronous or asynchronous modes.

- The Virtual Terminal Service (VTS) includes a variety of virtual objects such as printers, displays or keyboards.

- The VTS consists of a variety of display objects which are 1-3 dimensional arrays. Each point has attributes (i.e. color) and a value. Control objects help manage the use of multiple display objects on one device.

- VTS profiles are negotiated by the cooperating processes. ISO expects to add a registry of well-known profiles to the established default profiles. Standard profiles include:

    > Teletype-compatible displays (devices).

    > Page Oriented Displays

    > Videotext-type multi-page color displays

- The VTS includes extensions for blocks and fields within a display area. Fields can include an Entry Rules Control Object for data validation and control over movement.

Manufacturing Automation Protocols

- **Advocated by General Motors as a general purpose set of protocols for factory automation.**

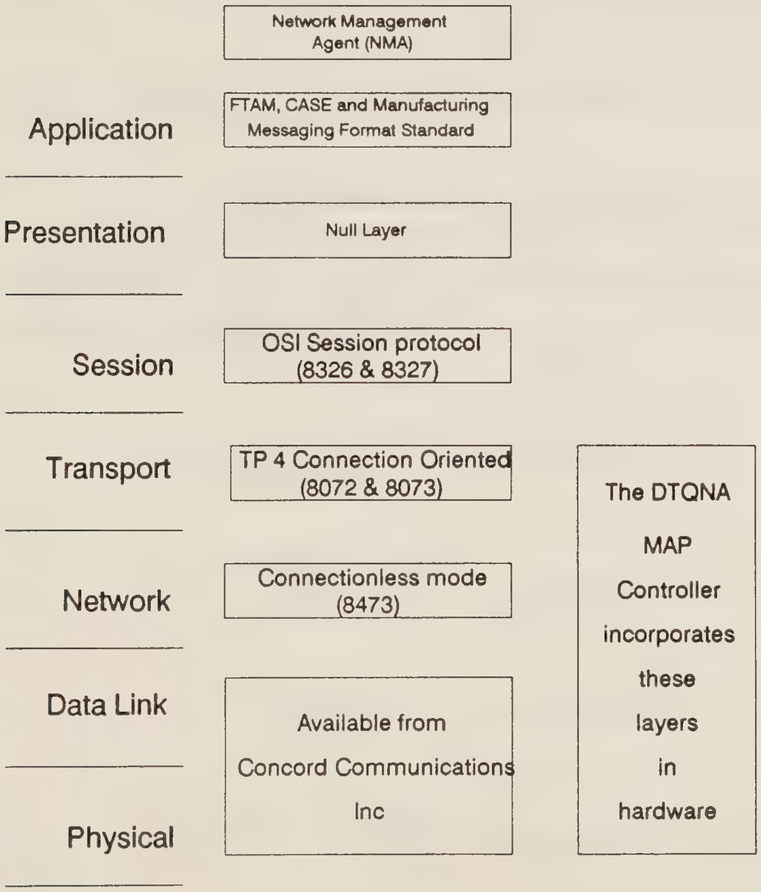
Application	FTAM MNS Directory Service
Presentation	OSI Presentation protocol (8823)
Session	OSI Session protocol (8326 & 8327)
Transport	TP 4 Connection Oriented (8072 & 8073)
Network	Connectionless mode (8473)
Data Link	Logical Link Control (8802/4)
Physical	Token Bus (Broadband) (8802/4)

[MAP]

VAX DEC/MAP

- DEC's implementation runs on Concord Communications' token bus modem. Currently available on Unibus and BI bus systems. Implements FTAM, CASE and the Manufacturing Message Format Standard, plus an interface to the transport layer.

- DEC participated actively in the Version 2 and 2.1 demonstrations of MAP. DEC will release MAP Version 3 this year.



	Network Management Agent (NMA)	
Application	FTAM, CASE and Manufacturing Messaging Format Standard	
Presentation	Null Layer	
Session	OSI Session protocol (8326 & 8327)	
Transport	TP 4 Connection Oriented (8072 & 8073)	The DTQNA MAP Controller incorporates these layers in hardware
Network	Connectionless mode (8473)	
Data Link	Available from Concord Communications Inc	
Physical		

Technical Office Protocol

- Where MAP is a means to tie together manufacturing systems, TOP is the means to tie the system design process to the manufacturing process. TOP is a logical extension of MAP in the manufacturing environment.

- TOP implements a subset of the OSI applications layer. ACSC, FTAM, VTS, and the directory service are supported. TOP uses the X.400 messaging system.

Application	FTAM MHS DS VTP
Presentation	OSI Presentation protocol (8823)
Session	OSI Session protocol (8326 & 8327)
Transport	TP 4 Connection Oriented (8072 & 8073)
Network	Connectionless mode (8473)
Data Link	Logical Link Control (8802/2)
Physical	Ethernet (8802/3) Token Ring (8802/5)

X.400

- X.400 is the CCITT model for message handling systems. A variety of other protocols and standards are defined for implementation, such as X.411 (definition of the message transfer layer) and X.408 (encoded information conversion rules.)

- X.400 is built on a concept of private and public management domains, user agents and message transfer agents.

- User agents are the user interfaces to a massaging system. This would be analogous to VAX Mail or All-in-One Mail. The Message Transfer Agent (MTA) is the interface to the routing systems. Analogous to the X.25 concepts of DTE and DCE.

- The provision for multiple management domains is a recognition that national telecommunications authorities will need to interface their services to corporate messaging systems.

X.400 Addressing

- X.400 is being defined with flexible naming schemes.
- Two naming schemes are being defined:
  - > X.121 Telex Address
  - > User Friendly scheme composed of country name, management domain, organization and personal name.
- X.400 directories are currently defined. They will allow you to verify the existence of a name, determine the members of a distribution list and map partial names into a possibility list.
- Directories are crucial to the operation of a mail system across heterogeneous environments. Will require a unified standard to allow locally maintained directories to be accessed from other nodes.
- DEC markets a directory product in conjunction with the Mailbus architecture.

Delivery

- X.400 defines the following delivery services:
  - > Multiple recipients
  - > Copies and blind copies
  - > Non-delivery notification
  - > Deferred delivery
  - > Deferred delivery cancellation
  - > Different priorities of delivery
  - > Autoforwarding
  - > Alternate recipients
  - > Timestamping and receipts

X.400 Access

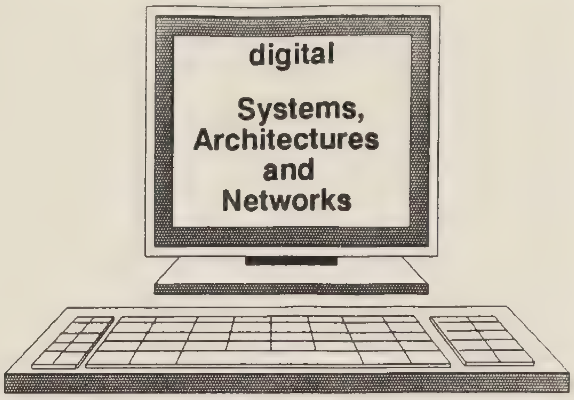
- Bundled software that is available on all VAXs and MicroVAXs. Requires PSI services to access X.25 and VOTS to set up the transport layer. X.400 Message Router software includes the VAX OSAK and X.400 software.

- The software includes a directory service to translate DEC addressing schemes into CCITT X.400 Originator/Recipient name forms.

- The message router needs to be connected to a user interface. If you use VMS mail, you need to also purchase the VMS Mail Gateway.

- The Data General CEO package and IBM's DISOSS have X.400 links.

- DEC has an X.400 electronic mail connection with MCI. This links DEC's internal mail system with a public mail carrier. DEC employees can now communicate with any MCI Mail Subscriber or CompuServe customer, as well as any Group 3 fax machine, any telex machine or any interconnected non-X.400 mail system.



Current Digital OSI Products

- > Token Bus Broadband
- > PSI X.25
- > Session and Transport Layers
- > Preliminary FTAM Support
- > X.400
- > MAP
- > Distributed Naming Service

Application		X.400 Gateway Message Router	DEC/ MAP
Presentation			
Session	OSAK		
Transport	VOTS		
Network			
Data Link	VAX PSI	IEEE 802.3	IEEE 802.4
Physical Link			

DNA PHASE V AND OSI

Key Concepts in This Section

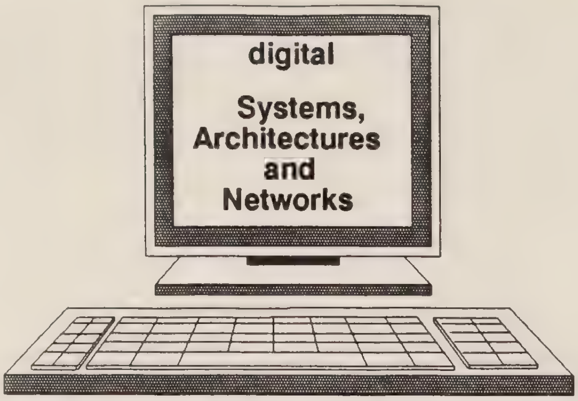
- Specific OSI services such as X.400, TOP and MAP are already in production. 21 vendors, including IBM, AT&T and DEC recently demonstrated X.400 interconnectivity. These existing products are already proving useful in integrating heterogeneous computing environments.

- DEC's implementation of OSI seems to be a serious attempt to open up the network architecture. It holds the promise of providing a stable, long-term open architecture for users.

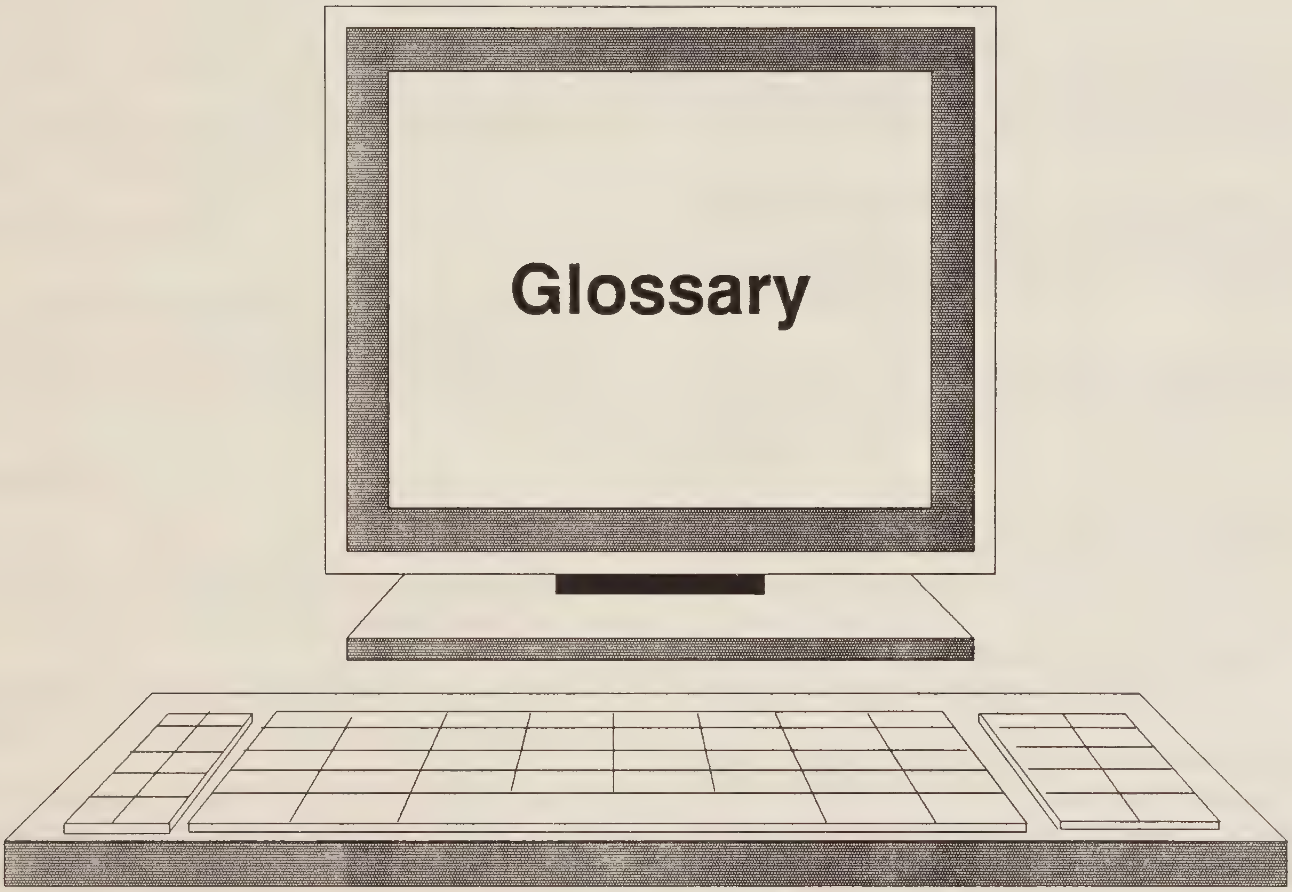
- There is still a good deal of crucial work to be finished by the standards committees, particularly in the definition of some of the upper layer services. Another critical issue will be the performance aspects of OSI implementations. Serious doubts have been raised in some quarters about the ability of a complex protocol stack to function effectively in a high bandwidth (100Mbps and up) environment.

"What's the worst they can do to me? Bend my dog tags and make me fly with night vision goggles on a Sunday night?"

David Snellen

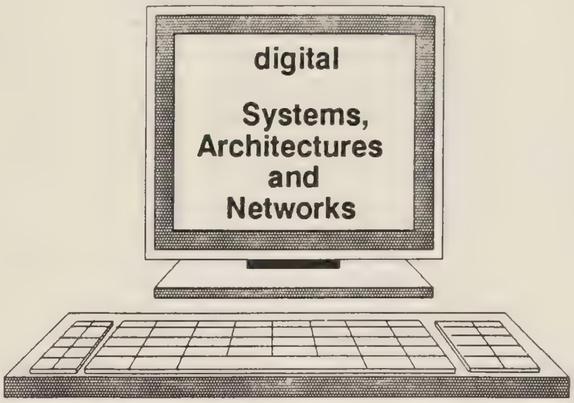


DNA PHASE V AND OSI



Glossary

GLOSSARY



2780/3780 A model of remote batch terminals used in IBM bisynchronous environments. Bisync gateways are often referred to as 2780/3780 emulators.

3270 A series of terminals used in IBM environments.

3274 A cluster controller for IBM equipment. Often called a terminal concentrator.

3480 IBM tape cartridges.

3705 An IBM communications controller. A PU Type 4 in SNA, used to connect token ring networks, cluster controllers, non-IBM SNA gateways and other devices to a PU Type 5 Host.

3725 See 3705.

3Com A communications company known for Ethernet controllers and PC-based networking equipment. Recently merged with Bridge Communications.

4.3BSD 4.3 Berkeley Software Distribution. The current version of the Berkeley family of Unix Products.

4010/4014 A series of Tektronix graphics terminals. A de facto standard for graphics terminals.

4GL Fourth Generation Language. New languages often linked with database packages such as Ingres or Oracle. Contrast with Fortran and other 3rd generation languages.

80286 An Intel chip, used in the IBM PC/AT and clones. The 80386 is used in new high end PS/2s and Compaq computers.

ACCOUNTING VMS utility that keeps track of sessions, including connect time, CPU usage and I/O usage.

ACK Acknowledgement. A data communications term for acknowledgement of information (packets) received.

ACL A security feature in the VMS operating system that allows security on objects to be specified as a list of permitted actions for particular lists of users.

ACMS Application Control and Management System. DEC's product for transactions processing. Used in conjunction with the Common Data Dictionary and TDMS Forms System.

ad hoc Latin phrase meaning for a specific instance. Used in computing to refer to not previously planned functions.

Adaptive routing When a line or communications path fails the network dynamically re-routes the message via the best available path.

Adobe Systems The company that makes the Postscript Page Description Language.

after image journal A database term that refers to a log of all permanent changes to the database. A similar concept is the before image journal that is used to keep track of changes in progress so that in the event of a system crash or other abort of the operation, the database can be restored to its previous state.

Aldus The company that makes the Pagemaker desktop publishing software.

Alis An integrated office automation package made by Applix that runs on Sun and DEC equipment.

All-In-One DEC's office automation shell, consisting of a menu driver, a mail user interface, a calendar manager and a file manager.

Alliant A manufacturer of mini-supercomputers. These computers are vector processors and complete with DEC in the high-end, computational-intensive markets.

ALOHA An experimental packet-switched network implemented on radio by the University of Hawaii in the mid-1970's.

ALTPRI A VMS parameter that allows a user to alter their priority for use of the CPU. Assigned in the AUTHORIZE utility.

ANSI American National Standards Institute. A leading standards-setting organization in the United States.

APPC Advanced Program-to-Program Communication. Sometimes known as LU6.2, refers to peer-to-peer communication in an IBM SNA network. Many advanced IBM architectures, such as DIA and DCA build on top of APPC.

Application Factory A 4GL that is compatible with the Digital Standard Relational Interface.

Applix Makers of Alis office automation software.

areas A DECnet term used in the Routing layer. Level 1 routers are used to route within a DECnet area. Level 2 routers route between ares. Up to 1023 nodes may be in an area, up to 63 areas in a DECnet.

Arpanet A Department of Defense sponsored network of military and research organizations. Being replaced by the Defense Data Network.

ASCII American Standard Code for Information Interchange. A 7-bit plus parity character set or code established by ANSI to achieve compatibility between data services. Normally used for asynchronous transmission. Equivalent to the ISO 7-bit code.

async Short of asynchronous or for aysnchronous transmission.

asynchronous Aysnchronous transmission. Method of sending data in which the interval between data bits may be of unequal length. No special synchronizing or timing is used.

AT Short-hand for the IBM PC/AT or any other Intel 80286-based processor that runs the DOS operating system.

AT&T American Telephone and Telegraph. Provider of long distance service, computing company known for the Unix operating system.

ATM Automated Teller Machine. Used in banking.

attenuation The weakening of a signal as it moves over the cable. At higher frequencies and temperatures, attenuation is greater.

AUTHORIZE A VMS utility used to add new users and define relevant parameters such as privileges, default login directories, etc...

autobaud The ability of a modem on the receiving end of a call to automatically detect the speed of transmission used by the calling modem.

AWK A pattern matching utility in the Unix operating system.

AWSA Automatic Working Set Adjustment. An internal mechanism in the VMS operating system that manages the memory pool in use by different processes.

AWSTIME A VMS SYSGEN parameter that determines how often the CPU stops to evaluate memory utilization. Part of the AWSA.

backbone A networking term used to refer to a piece of cable used to connect different floors or departments together. Contrasted with a departmental network or work area network.

backup Making a copy of stored information in case the original repository (usually a disk drive) becomes corrupted. To be contrasted with the alternate meaning of the word, "to overflow", which is usually used in the context of plumbing and sewage.

bandwidth The range of frequencies available for signaling; a measure of information carrying capacity; the difference between the highest and lowest frequencies of a transmission channel, expressed in Hertz (Hz).

baseband COAX cable implementation of Ethernet. Also known as ThickWire.

baud A unit of signaling speed. A term used with older (slow) modems to refer to each modulation of an analog signal. A 300 baud signal modulates 300 times per second. A more accurate term for faster modems is bits per second as several bits can now be carried on one modulation of the signal.

BBN Bolt, Beranek, and Newman. A company specializing in communications. Responsible for the Defense Data Network.

before image journal See after image journal.

BI-bus Backplane Interconnect. A peripheral bus used on DEC's 8000 series VAXs. The Bi bus operates at a speed of 13.3 MB/s.

Bisync A synchronous protocol used in older IBM teleprocessing environments. See also BSC.

BLOBS Basic Large Objects. A term used by the Interbase DBMS to refer to pointers in the relational tables to other objects such as files.

block A unit of I/O on VMS computers. 512 Bytes.

Boot node A system responsible for loading another device's memory with sufficient information so that it can function.

boot nodes Used in Local Area VAX Clusters to refer to the node that stores the operating system for other nodes in the cluster.

BORROWLIN A SYSGEN parameter in the VMS operating system that defines when unused cache space in the system memory pool can be used by a process.

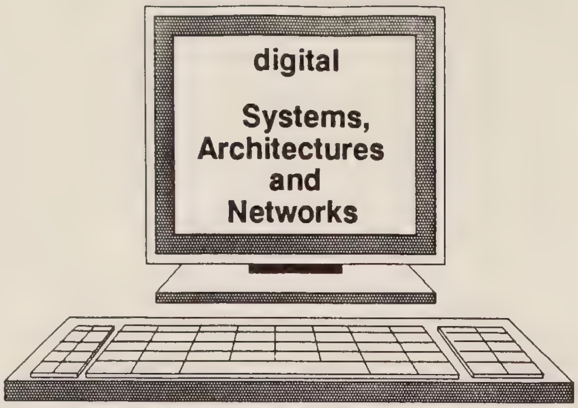
Bourne Shell A user interface on the Unix operating system. The Bourne shell was one of the original shell's used in the AT&T versions of Unix.

bps bits per second. Transmission speed on modems, phone messages and other data communications device.

bridge A device used to connect two separate networks using the same communications protocols. Bridges use a store and forward packets destined for the other network. Bridges work at the data link layer of the OSI model.

Britton Lee Manufacturers of data base machines.

broadband An analog media similar to cable TV. Large bandwidth and very long distances make this media appropriate for college settings. Used with various data link protocols including Ethernet and Token Buses.



BRS Bibliographic Retrieval System. Text search software package.

BSC Bisynchronous. See Bisync.

BSD Berkeley Standard Distribution. See 4.3BSD.

bursty traffic Data communications term referring to an uneven pattern of data transmission.

byte A collection of bits operated upon as a whole; most bytes are 8 bits long.

C A programming language. Very popular in the Unix environment.

C Shell A user interface for Unix typically found in the Berkeley versions.

cache A portion of memory used as a buffer between a fast CPU and a slower I/O device. Most often used to buffer disk input. On faster computers, a cache is used to buffer memory.

CAD/CAM Computer Aided Design/Computer Aided Manufacturer. Software/hardware combinations for the automation of engineering environments.

CASE(1) Computer Aided Software Engineering. A term used to refer to a set of tools that help automate and control programming environments.

CASE(2) Common Application Service Element. Term used in the OSI application layer services to refer to a service used by all types of applications

CATV Community antenna television. One of the more common facilities found on broadband networks.

CCITT Consultative Committee for International Telephone and Telegraph (Comite Consultatif International Telegraphique et Telephonique). An international standards making body consisting of the national telecommunications authorities. Recommendations are known by their numbers, i.e. X.25 for packet switched networks, X.400 for message handling systems.

CCITT X.21 Physical layer digital interface.

CCITT X.25 X.25 layer 3 protocol and HDLC/LAPB data link layer protocol.

CCITT X.400 Message handling (electronic mail).

CCR Commitment, Concurrency and Recovery. Part of the OSI CASE services that allows the coordination of multiple users access to data on multiple nodes.

CCTV One of the many services often found on broadband networks.

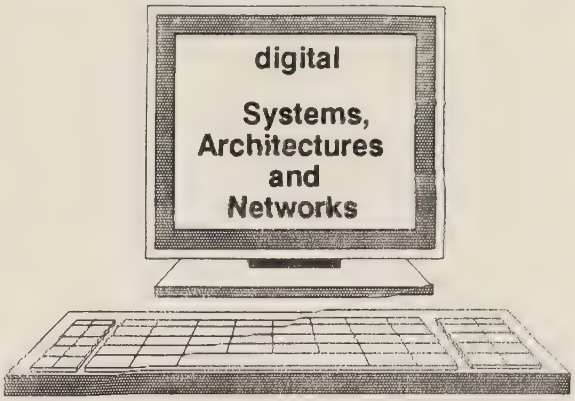
CD-ROM Compact Disc-Read Only Memory. Optical discs that are mastered and then can only be read. Used for read only databases.

CDA Compound Document Architecture. DEC's new architecture that defines a software-independent means of representing documents containing both text and graphics.

CDC Control Data Corporation. A leading manufacturer of disc drives and large computers.

CDD Common Data Dictionary. DEC's software that functions as a common repository for data definitions, forms, database schemas and other parts of an information system. Part of the VAX Information Architecture.

CEO Chief Executive Officer. A Data General office automation software package.



channel An IBM term referring to a direct high speed connection into the 370 architecture machine. A "channel attach" gateway operates at speeds of up to 3 MBs/s, as opposed to more traditional gateways that attach to a communication controller at 56 kbps.

cheapernet Another term for ThinWire Ethernet cables.

CHIPCOM A manufacturer of broadband Ethernet equipment.

CI Computer-room interconnect. Refers to the 70 mbps bus and controllers used in the VAX Cluster arrangement. To be contrasted with Local Area VAX Clusters that use a 10 mbps Ethernet as the transport mechanism.

CICS Customer Information Control System. An IBM data communications interface used typically with the MVS operating system.

Client A system that requests service from another system.

clusters A DEC architecture for VMS nodes only that allows several systems to have a common security/management domain and transparent access to the same disk drives.

CMS Code Management System or Conversational Monitor System. Code Management System is a DEC software product used in the VMS environment as a library for program development. Conversational Monitor System is the user interface on IBM's VM/CMS operating system.

coax A type of cable, used for IBM 3270 terminals, as well as for baseband and ThinWire Ethernets.

Cobol Common Business Oriented Language. One of the first standardized computing languages. See CODASYL.

CODASYL Conference on Data Systems Languages. The folks that brought you Cobol as well as the CODASYL standard for data bases using the network model of data management.

collision Two stations trying to transmit at the same time.

conferencing A term used for communication software that allows participants to "post" notes. Contrasts with electronic mail in that participants do not have to be explicitly addressed. Also known as a bulletin board.

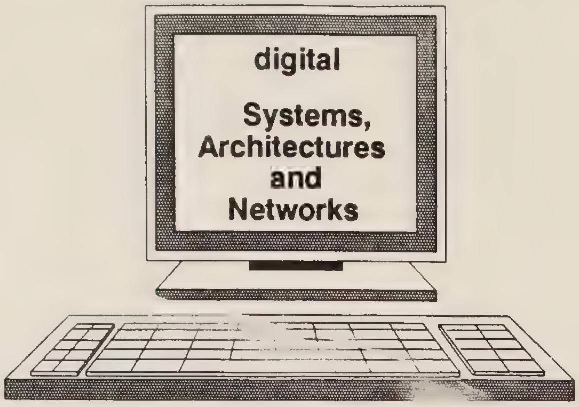
connection manager A cluster term used to refer to the software component in a VAXcluster or LAVC that maintains the integrity of the cluster by managing state transitions.

Convex A manufacturer of super mini-computers. See Alliant.

CPU Central Processing Unit. You know...the computer part of the computer.

CRC Cyclic Redundancy Check. An error checking mechanism for data communications. A code is generated based on the values of the data transmitted and the resulting number is tacked onto the end of the data. The receiving end recalculates the CRC and compares it to the CRC received.

cross modulation A broadband term that describes interference caused by another frequency. It comes from the network branches. If a signal is increased, too much modulation occurs.



CSMA/CD Carrier Sense-Multiple Access/Collision Detect. A control method for a network. Ethernet is an example of a CSMA/CD type of data link protocol.

CTERM Communications Terminal Protocol. Part of the Virtual Terminal service in layer 6 of the Digital Network Architecture.

Cullinet Software company that markets the IDMS database package.

Culprit A Cullinet software package used in the IBM environment used to extract data from other DBMS systems such as IMS.

daemon A Unix term referring to a process that is not connected with a user but performs services, such as a mail daemon. The equivalent VMS term is a detached process.

DAP Data Access Protocol. A protocol used in the Digital Network Architecture in layer 6. Provides a rich set of functions used for exchanging data between two nodes of the network. See FAL.

DARPA Defense Advanced Research Projects Agency. A Department of Defense agency that has helped fund many computer projects including Arpanet, the Berkeley version of Unix and TCP/IP.

Data Distributor A DEC software product for extracting portions of DSRI compatible data bases and replicating this data on another node of the network as an Rdb database.

Data General Maker of minicomputers that compete with VAX systems.

datagram An unacknowledged packet of data in a network. As opposed to packets that require acknowledgement of receipt (also known as reliable communications).

DATAPAC Canadian public packet switched network.

Datatrieve A DEC data manipulation language for access to RMS files, VAX DBMS data bases and Rdb data bases. Used in conjunction with the Common Data Dictionary (CDD).

DB2 An IBM data base package based on the relational model and the SQL query language.

DBA Database Administrator. A staff function for managing database software.

DBM Database Machine. A generic term for hardware that has been optimize for relational data base functions. See Britton Lee.

DBMS Database Management System. Software that allows the centralized storage of data with multiple concurrent users, access control and the use of a high level data manipulation language such as SQL.

DBO Database Operator. DEC's user interface for Rdb.

DCA Document Content Architecture or Defense Communications Agency. Document Content Architecture is an IBM architecture similar in function to DEC's Compound Document Architecture (CDA). The Defense Communication Agency is responsible for the Defense Data Network.

DCE Data Circuit-Terminating Equipment. A term in X.25 networks that refers to the interface to the communications network. See also DTE.

DCL Digital Command Language. The user interface in the VMS operating system. Similar to the C Shell in the Unix operating system.

DDCMP Digital Data Communications Message Protocol. A data link protocol used in the Digital Network Architecture. Used for point to point links between nodes, either synchronous or asynchronous.

DDIF Digital Document Interchange Format. The part of DEC's Compound Document Architecture (CDA) that specifies how revisable form documents are to be stored.

DDN Defense Data Network. A network for DoD and DoD contractors based on the TCP/IP and X.25 networking protocols.

DDXF DISOSS Document Exchange Facility. DEC software product that allows transfer of data between DEC and IBM word processing environments. See also EDE.

DEBET Model number for the DEC LAN Bridge 100 used for creating extended Ethernets.

DEC Digital Equipment Corporation

DECconnect A DEC cabling architecture used for facilities wiring.

DECmate A piece of DEC hardware roughly equivalent to a PC but only runs the WPS word processing system and a few miscellaneous utilities.

DECnet An implementation of the Digital Network Architecture by DEC, as opposed to implementations of DNA by other vendors.

DECnet-RSX Software allows suitably configured PDP-11 computer systems to participate as a node in a DECnet network.

DECnet/DOS The version of DECnet for the PC or MS-DOS operating systems.

DECOM A broadband Ethernet modem made by DEC. A DECOM-AA is a dual cable modem, the DECOM-BA is a single cable version.

DECserver DEC terminal servers.

DECtalk A piece of DEC hardware that can "speak" ASCII files.

DECUS Digital Equipment Corporation User Society. DEC user group.

DEFTR DEC Frequency Translator. DEC's frequency translator for single-channel broadband systems.

DELNI DEC Local Network Interconnect. "Ethernet in a Can." A multiport transceiver made by DEC.

DELUA DEC Local Unibus Adapter. An Ethernet controller made by DEC for UNIBUS processors.

DEMPR DEC Multiport Repeater. A piece of DEC networking hardware that can connect up to 8 ThinWire Ethernet segments and optionally connect them to a backbone cable or DELNI.

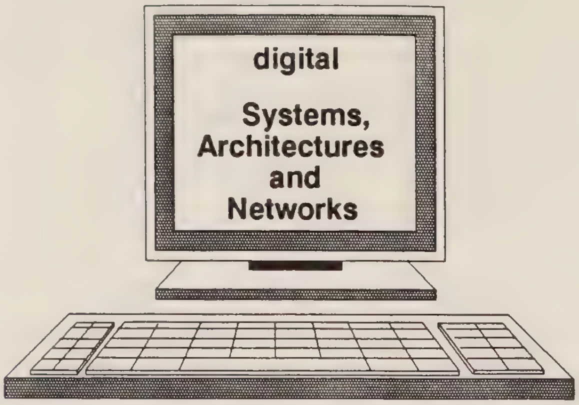
DEQNA DEC Q-Bus Network Adapter. A DEC Ethernet controller for Q Bus systems.

DEREP DEC Repeater. DEC Ethernet repeaters.

DES Data Station Adapter. DEC ThinWire transceiver.

DFM DEC Frequency Multiplexor. A series of DEC products including X.25 asynchronous PADs and multiplexors.

DFS Distributed File System. A DEC product similar to the Network File System (NFS). Both allow remote files to appear as if they were locally mounted on a workstation, allowing diskless nodes. DFS uses the DNS nameserver.



DHCF Digital Host Command Facility. A DEC software product that, in conjunction with IBM's Host Command Facility allows an IBM terminal user to log onto a DEC network.

DIA Document Interchange Architecture. An IBM architecture for the interchange of messages. Usually used in conjunction with the Document COntent Architecture (DCA). Implemented in a product called DISOSS.

Dialog An on-line bibliographic information service.

directional couplers Broadband passive components that divide the signal unequally. Similar to a splitter, except splitters divide the signal equally.

DISOSS An IBM product that serves as a distributed library of documents. See DIA/DCA.

DMA Direct Memory Access. Allows a device on a computer to access main memory without a CPU interrupt.

DMB32 DEC VAXBI bus based communications controller.

DMF32 DEC UNIBUS-based communications controller.

DML Data Manipulation Language. A language, such as SQL, used for retrieving and manipulating data in a database system.

DNA Digital Network Architecture. Architecture for DECnet.

DNS Distributed Naming Service. Apart of DECnet Phase V currently released. Provides name translation, such as node name to DECnet address translation. Also used for the location of DFS files.

DoD Department of Defense. Makes a $10 billion company like DEC look like your local ACE hardware store.

DOS Digital Operating System. Microsoft operating system for IBM PCs.

DOS/VSE An IBM operating system used on 370 architecture mainframes.

downline loading The process of sending configuration parameters, operating software or related data from a central source to individual stations.

DP Data Processing. Typically a centralized department in an organization charged with maintaining computer equipment and software.

DSA Digital Storage Architecture. DEC architecture for mass storage devices and controllers.

DSRI Digital Standard Relational Interface. DEC standard calling sequence for data base applications. Allows any DSRI-compatible user interface to access any DSRI-compatible data repository.

DSRVB DEC terminal server model number.

DSS Distributed System Services. A family of DEC software including the Distributed Name Service (DNS) and the Distributed File Service (DFS).

DTE Data Terminal Equipment. A X.25 term referring to the interface to users equipment as opposed to the DCE interface to the network.

DTF Data Transfer Facility. DEC software products that run in both VMS and IBM environments and permit the integration of both types of file systems from within the Digital Command Language.

dX DEC software product for transfer of WPS documents into other formats.

EBCDIC Extended Binary Coded Decimal Interchange Code. A character code scheme used in IBM environments. See ASCII.

ECC Error Correcting Code. Feature of the Digital Storage Architecture used in error detection. Similar to a CRC.

EDE Electronic Document Exchange. DEC product that allows revisable form document transfer with DISOSS libraries. See also DDXF. EDE-W is a similar program for document interchange between Wang and DEC systems.

EDI Electronic Data Interchange. A generic term referring to the communication of information between different organizations by computer instead of paper. For example, submitting a purchase order by modem instead of paper or FAX.

EDT Standard DEC editor on the VMS operating system.

ELXSI Manufacturer of a parallel processing minicomputer that has a variety of DEC emulation tools.

EMACS An extensible editor developed at M.I.T. based on the LISP programming language.

Email Electronic Mail. Software/networks that allow the exchange of messages between users.

EMBOS Elxsi Message Based Operating System. Operating system for Elxsi, on top of which a variety of Unix and VMS emulation operating systems can run.

EMC Maker of DEC-compatible peripherals such as disk controllers and optical disc systems.

EMS Elxsi's VMS emulator.

Emulex A large manufacturer of disk drives and other peripherals for DEC equipment.

end node A DECnet term referring to a member of a network that can do everything but route packets through on behalf of other nodes. Ultrix, MS-DOS and third-party implementations of DECnet are all end nodes.

Epson Maker of dot matrix printers. Most software systems have printer drivers for an Epson printer, making it a lowest common denominator.

Ethernet A data link protocol jointly developed by Intel, Xerox and DEC. Subsequently adopted by the IEEE as a standard. Several upper layer protocols, including DECnet, TCP/IP and XNS use the Ethernet as an underlying transport mechanism. Ethernet may be contrasted with other data link protocols such as the Token Ring, DDCMP or SDLC.

EUNICE Software made by the Wollongong Group that allows emulation of Unix on a VMS system.

EVE Extensible VAX Editor. A fairly new editor from DEC for VMS systems. Replaces the EDT editor. Because EVE is built on top of the Text Processing Utility (TPU), it is easy to program new functionality into the editor.

exchange steps A concept in the ACMS software product referring to the exchange of information between the screen and a working area. Usually accomplished with a TDMS request. See also processing steps.

EXPECTED_VOTES A DEC SYSGEN parameter assigned to every node in a Cluster. See also QUORUM.

EXQUOTA A VMS privilege that allows the user to exceed disk quota restrictions.

F$FILE_ATTRIBUTES A VMS lexical function that returns information about file attributes.

F$GETJPI Get Job Process Information. A VMS lexical function that returns about processes on the system, such as the name of the program that process is currently running.

F$GETSYI A VMS lexical function that returns information about the system, such as the name of the node on the network.

F$PID A VMS lexical function that returns the process ID number for all processes the user is allowed to observe.

FAL File Access Listener. A process invoked across the network by a user trying to access data on nonlocal systems. A FAL is a DAP-speaking process invoked by the Record Management Services on the local node.

FI.FMD Functions Interpreters for Function Management Data. IBM's presentation layer protocol for SNA.

field A term used in designing forms-based systems such as database applications. A field is a portion of the screen used for data input which is automatically mapped to a variable. The field may have attributes such as reverse video or default values.

Firefly A DEC research project aimed at producing a 30 to 50 MIP desktop workstation. See Topaz.

FMS Forms Management System. A DEC programming utility that allows the definition of forms and actions to take when a field is left or certain keys pressed on the keyboard. Used for user extensions of All-in-One systems.

FORTRAN Formula Translator. A 3GL programming language used frequently in scientific and mathematical applications.

FREELIM A VMS SYSGEN parameter used by the Swapper Trimmer mechanism to determine if there are enough modified pages to make it worthwhile to write them to disk and free memory space.

FTAM File Transfer, Access and Management. The OSI application layer service that provides access to virtual filestores on foreign systems. Similar to the DNA DAP protocols in purpose.

FTP File Transfer Protocol. An upper layer TCP/IP service used in the ARPANET implementation for the copying of files across the network.

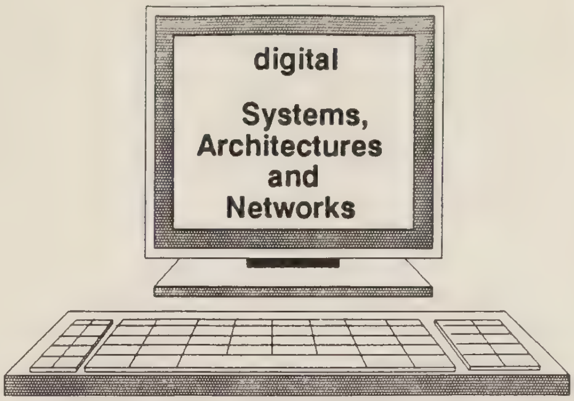
Gandalf A manufacturer of communications equipment including data switches.

GAP Gateway Access Protocol. A protocol used by applications software to access DECnet Gateways. The 3270 access routine, for example, would use GAP to access an SNA Gateway.

gateway There are two somewhat conflicting definitions of gateway, both used in networking. In the general sense, a gateway is a computer that connects two different networks together. Usually, this means two different kinds of networks such as SNA and DECnet. In TCP/IP terminology, however, a gateway connects two separately administered networks, which may or may not be running the same networking protocols.

GBytes Gigabytes. Billions of bytes of data.

GM General Motors. Primary supporter of the Manufacturing Automation Protocol (MAP). They also make cars.



GOSIP Government OSI Profile. U.S. government version of the international OSI standards.

Gould Manufacturer of minicomputers. See Power-Nodes.

granularity A term used in lock managers on an operating system. When the lock manager locks an entire file, this is locking with course granularity. When the lock manager locks a single record, this is fine granularity. Granularity is one of the factors that influences the performance of a particular application, such as a DBMS.

GREP g/regular expression/p. A Unix utility that prints all lines that match a regular expression in a specified set of files. The name comes from the syntax used for the command in the ED editor.

GS/3 A device made by Bridge Communications that serves as a level 3 router between Ethernets and other GS/3s.

H4000 DEC's baseband Ethernet Transceiver.

HASP Houston Automatic Spooling Program. One of the original implementations of the Remote Job Entry function on IBM equipment. Still used as a common denominator, in conjunction with Bisync, for RJE functions.

HDLC High Level Data Link Control. International Standard Organization's data link protocol. Used in OSI and X.25 networks. Alternative protocols include SDLC in the IBM networks or DDCMP in the DEC networks.

Hewlett Packard Makers of a wide range of equipment that competes with or complements the DEC product line, including lazer printers and minicomputers.

HOPS A term used in DECnet routing calculations. A hop is one data link. A path to the final destination on a DECnet is a series of hops away from the origin. Each hop has a cost associated with it, allowing the calculation of the least cost path.

HSC70 Hierarchical Storage Controller. Stand-alone disk and tape controller used in clusters using the CI bus.

I/O Input/Output. Generic term for transfer of data from main memory to either a disk drive, terminal, printer or other device.

IBM International Business Machines Corporation.

IDMS Cullinet's data base management system for IBM systems.

IEEE Institute of Electronic and Electronic Engineers. A leading standard-setting group in the U.S. IEEE 488 is a popular standard for real-time data collection. IEEE 802 is the standard for various types of Ethernets.

IEI Information Engineering Institute. Sponsor of this seminar.

IMS Information Management System IBM's data base management software based on the hierarchical data management model.

Informix A popular relational data base management system that runs on a variety of operating system platforms.

Ingres A popular relational data base management system that runs on a variety of operating system platforms.

INQUIRE A DCL command that is used in command procedures to prompt for user input.

insertion loss A broadband term that describes the weakening of signal strength as the signal passes through a device. Every passive component has a specific insertion loss. Insertion loss increases as the frequency rises. Amplifies compensate for the loss by boosting the signal.

Interbase A data base management system that is compatible with the Digital Standard Relational Interface.

Interleaf A desktop publishing program that runs on VAXStations and Sun workstations.

Interlink A manufacturer of SNA gateways.

IOP Input/Output Processor. Term used by Unix-based minicomputer manufacturers to refer to the I/O subsystems.

IP Internet Protocol. Layer 3 of the TCP/IP network protocols.

IP/TCP Software product sold by the Wollongong Group. Allows VMS nodes to participate in TCP/IP networks. A similar product is sold by Excelan.

IRDS Information Resource Dictionary System. A new ANSI standard for data dictionaries.

ISDN Integrated Services Digital Network. A new international communications standard allows the integration of voice and data on a common transport mechanism.

ISO International Standards Organization. International standard making body responsible for the OSI network standards and the ISO Reference Model.

ISO 7498 The ISO OSI basic reference model.

ISO 8072 Connection-oriented transport service.

ISO 8073 COnnection-oriented transport protocol.

ISO 8326 Connection-oriented session service.

ISO 8327 Connection-oriented session protocol.

ISO 8571 File transfer access and manipulation service.

ISO 8572 File transfer, access and manipulation protocol.

ISO 8802 Local area networks.

ISO 8822 Connection-oriented presentation service.

ISO 8823 Connection-oriented presentation protocol.

ISO 8831 Job transfer and manipulation service.

ISO 8832 Job transfer and manipulation protocol.

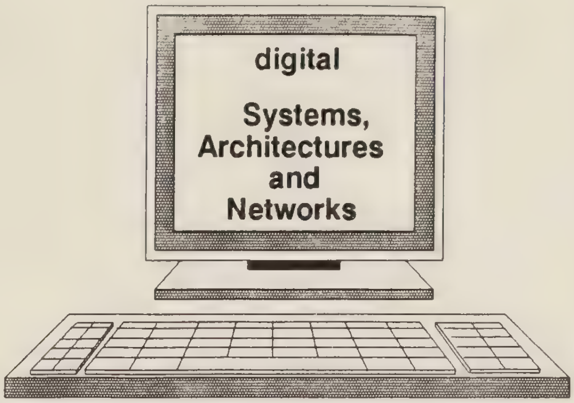
ISO 9040 Virtual terminal service.

ISO 9041 Virtual terminal protocol.

JCL Job Control Language. Language used for batch processing on IBM mainframes.

JOINDEF Join Definition. A term from the Ingres data base management system. Refers to the definition of how two tables are joined together and what rules to follow in the case of updates or deletes to the joined table.

joins A term from relational data base theory. Two tables will often contain a common column allowing the information in one table to be related to another. For example, the last name column in a salary table might be joined with the same column in an address table to produce a listing of employee names, addresses and salaries.



journal A log of all changes to a data base. Used to recover information accidently deleted at a later time.

JTM Job Transfer and Manipulation An OSI layer 7 standard similar in function to a Remote Job Entry (RJE) service.

Kbps kilo bits per second Thousands of bits per second.

KBytes kilobytes. Thousands (1,024) of bytes of information.

KDA50 A DEC DSA-compatible disk controller used on Q-Bus systems such as the MicroVAX.

KDB50 A DEC DSA-compatible disk controller used on Bi Bus VAX systems.

Kermit A popular file transfer protocol developed by Columbia Universities. Because Kermit runs in most operating environments, it provides an easy method of file transfer.

kernel A term used in operating systems. The kernel shields the low level functioning of the operating system from high level interfaces, such as user shells.

LA100 A DEC dot matrix printer commonly found in machine rooms as console printers.

LAN Local Area Network. Usually refers to Ethernet or Token Ring networks.

LAT Local Area Transport. A proprietary DEC architecture for terminal servers on Ethernet networks designed to conserve bandwidth and offload processing from hosts.

LAVc Local Area VAXcluster. An adaptation of the System Communication Architecture (SCA) to run over the Ethernet instead of a CI Bus. Used to enable MicroVAXes to operate as diskless nodes.

LEX Lexical Analyzer. A Unix tool used in conjunction with YACC for building incoming text into tokens which is then fed into a parser built using YACC.

Lexical function A series of Digital Command Language functions used to return information about the system, processes, files and other objects on a VAX. See for example F$GETJPI.

LN03 DEC's first 8 PPM laser printer. LN03s used a proprietary language and have been superceded by the Scriptprinter, which uses the sam engine but the Postscript page description language.

LOCKPWD An AUTHORIZE flag that prohibits the user from changing the password on an account.

logical A Digital Command Language feature which allows the logical naming of devices, permitting a layer of separation between the physical configuration of a system and the logical view seen by the user process.

LOGIN.COM A command file on VMS which is automatically executed every time a user logs in if it is present in a directory represented by the logical name SYS$LOGIN.

LPS40 DEC's 40 page per minute laser printer. Uses the postscript page description language.

LSE Language Sensitive Editor. A DEC software product built using the TPU text processing language. LSE has language sensitive templates to help enforce proper syntax and style in programming.

LU Logical Unit. An IBM term in SNA which refers to a software or microcode program that uses the network. For example, a terminal connected to a 3274 cluster controller is represented by a LU2 on that cluster controller.

LU6.2 See APPC.

MAC Media Access Control. A communications term referring to the method of controlling access to a broadcast media, such as an Ethernet. The Ethernet uses CSMA/CD as a MAC-layer protocol.

mail A Unix command for electronic mail.

Mailbus A DEC architecture which provides a common message handling system on a DECnet.

MAP Manufacturing Automation Protocol. An OSI-related application sponsored by General Motors and endorsed by a great many users and vendors.

MASSBUS A bus structure used to enhance I/O processing power on Unibus-based VAX processors.

Mbps Million bits per second.

MBytes Mega Bytes. Million (1,000,000) bytes of information.

MC68000 A series of CPU chips manufactured by Motorola. These form the basis for many Unix-based workstations, including the MAC II and the Sun 3 series.

MCI Long distance telephone company.

Metaphor Makers of workstations designed around DBMS access. The DBMS is usually a Britton Lee machine or an Oracle system. The workstations have an iconic interface and make heavy use of graphics in the user interface.

MFLOPS Million Floating Point Operations Per Second. A measure of processor speed used for computationally intensive applications. Processors by Alliant and Convex are usually measured in Mflops instead of MIPS.

MHS Message Handling System. A system of protocols, such as X.400, used to exchange messages, such as electronic mail.

MicroVAX A series of DEC processors using the Q-bus and competing in the workstation market with Sun and Apollo.

MIPS Million Instructions Per Second. A measure of CPU processing power. Different machine architectures use different instruction sets, so comparisons of MIPS across products is highly misleading. MIPS also do not take into account the mix of other resources such as bus speeds, I/O processors, disk drive throughput, main memory, network controllers and other components.

MMS Module Management System. A DEC program development product used to automate the steps needed to compile and link complex software systems.

modem Modulator/Demodulator. A device that takes digital device from a computer and encodes it in analog form for transmission over a phone line. Modem's are also used to connect computers to an analog broadband system.

Modula An extension of the Pascal programming language.

MONITOR A VMS tool used to examine the current status of a system.

MOP Maintenance Operation Protocol. A DECnet protocol used to efficiently download large files. Used for downline loading of the operating system for one component from another system.

MS-DOS Microsoft-Digital Operating System Microsoft's version of PC-DOS.

MSCP Mass Storage Control Protocol. The protocol used by HSC storage controllers to communicate with device drivers on the VAXes in a cluster.

Mt. Xinu A company that sells various versions of Unix, including one for VAX systems.

MTA Message Transfer Agent. An X.400 term referring to the collections of network members responsible for transferring messages. The final MTA delivers the message to a User Agent which is concerned with reading, editing, and other types of interaction with the end user.

Multiplex A software product made by Network Innovations (owned by Apple) that retrieves information from a variety of VAX database packages and translates it into a variety of different

MVS/TSO Time Sharing Option. MVS is an IBM operating system. TSO is an interactive subsystem, as opposed to a system like JES used for batch processing.

NAK Negative Acknowledgement. Response to non-receipt or receipt of a corrupt packet of information.

NAU Network Addressable Unit. The boundary of an IBM SNA network. Logical and Physical Units are examples of NAUs.

NCP Network Control Program. A DEC user interface to the network management layer of the Digital Network Architecture.

Netbois Network Basic Input/Output System. Used in Dos as the interface to the network for accessing information. Similar in function to the DNA DAP protocols.

NETMBX access to the network. This does not mean that any remote system will allow access - only that the current system will allow outgoing traffic for this account.

NeWS Network Extensible Window System. A Sun Microsystems windowing environment based on the Postscript language and a proprietary window control protocol.

NEXT Inc. Computer company founded by Steve Jobs, formerly of Apple.

NFS Network File System. An extension to TCP/IP developed by Sun Microsystems and licensed free of charge. NFS allows files on remote nodes of a network to appear locally connected.

NICE network information and control exchange A DECnet protocol used for the exchange of network management information.

NMX-432 An array processor made by Numerix that attaches to VAX processors.

node A member of a network. A VAX is a node on a DECnet. A PC is sometimes a node on the network, and sometimes just emulating a terminal and thus not a node.

noise Unwanted interfering signals.

non-routing See end node.

Novell Makers of PC-based local area networks.

NSP Network Services Protocol. A protocol used at the End to End Communication layer of the Digital Network Architecture to assure reliable communications.

OA Office Automation. Whatever's in Datamation this month.

OEM Original Equipment Manufacturer. Company who sells equipment which is embedded in another company's products. The other company is known as a Value Added Reseller (VAR) of the product.

OIS A WANG operating system.

Oracle A relational data base management system which runs on a wide variety of operating systems.

OS/2 Operating System/Two. IBM's replacement for DOS.

OSAK OSI Applications Kernel. A set of program libraries sold by DEC as the interface to layer 5 of the OSI model.

OSI Open Systems Interconnect. The International Standards Organization's implementation of the OSI Reference Model.

PAD Packet Assembler/Disassembler. A piece of hardware used in packet switched networks to allow asynchronous terminals to participate in the network.

Pagemaker Desktop publishing software made by Aldus and sold by DEC for VAXmates.

paging A memory management technique in a virtual memory operating system. Only a few parts (pages) of a program are actually in memory. When a new part is needed, it is paged into memory.

PAR Positive Acknowledgement Retransmit. A method of assuring reliable communications used by the DDCMP data link protocol.

PARC Palo Alto Research Center. Xerox PARC is a research institution responsible for many modern developments in computing, such as the MacIntosh-style of user interface and the Postscript language.

PC Personal Computer. IBM series of computers or clones.

PC-DOS Personal Computer - Digital Operating System. IBM's version of Microsoft's operating system.

PCA Performance Coverage Analyzer. DEC program development software used to analyze how much execution time is spent in various parts of a program.

PDL Page Description Language. Postscript is an example of a PDL.

PDP Programmable Data Processor. A series of Q-bus based, 16-bit minicomputers manufactured by DEC.

Phase IV The current phase of DECnet.

PHONE A VMS program that allows interactive two-way conversations over a DECnet.

PID Process Identification Number. Used to identify each process running on an operating system. The VMS lexical function

Polygon Associates Makers of Pol-xfr terminal emulation software for PCs.

Postscript A page description language developed by Adobe Systems. Widely adopted by many vendors as a de facto standard.

Powernodes A series of Gould minicomputers that run the Unix operating system.

ppm Pages Per Minute. Rating measure for laser printers.

processing steps Part of an ACMS transaction. See exchange steps.

PROFS IBM Office Automation system that runs on the VM operating system.

PS Profiles Presentation Services Profiles. An SNA term used to allow two NAUs to negotiate an acceptable subset of presentation functions they can both support.

PSI Packet Switch Interface. DEC software to allow a VAX to participate in an X.25 network.

PSN Packet Switched Network. An X.25 network.

PU Physical Unit. An SNA term used to refer to different types of hardware in the network. A 3274 cluster controller is a PU type 2 (PU_2).

Q-bus The peripheral bus used on MicroVAX and PDP computers.

QBF Query By Forms. Generic name used for a method of querying a data base by filling in examples on a form using wild cards and matching characters.

QIO Queue Input/Output. Device dependent layer in the VMS operating system.

Quantum A VMS SYSGEN parameter which controls the time-slice allotted to each process that obtains the CPU.

Quorum A VMS SYSGEN parameter which is used by the System Communication Architecture in a cluster to determine if there are enough VOTES to keep a cluster intact.

R:Base A PC-based data base management package manufactured by MicroRIM.

RA60 A 205 MBytes, removable media disk manufactured by DEC which is compatible with the Digital Storage Architecture.

RA70 A 256 MBytes fixed media DSA disk made by DEC.

RA81 A 450 MBytes fixed media DSA disk made by DEC.

Rally A DEC user interface to DSRI-compatible data base systems.

RAM Random Access Memory. Dynamic memory, sometimes known as main memory or core.

RCP Remote Procedure Call. Part of the Network File remote copy program. An upper layer TCP/IP service System. This is the layer 5 (Session Layer) services built on top found in the Berkeley Unix implementation for copying files. See of TCP/IP. FTP for the Arpanet equivalent.

Rdb DEC's relational data base management system.

ReGIS Remote Graphics Instruction Set. A set of DEC protocols used in the VT240 and 241 graphics terminals.

RISC Reduced Instruction Set Computer. Generic name for CPUs that use a simpler instruction set than more traditional designs. Examples are the IBM PC/RT, Pyramid minicomputers, the Sun 4 (SPARC) Workstations.

RJE Remote Job Entry. Facility for submitting a job to a computer for execution. Card readers were early RJE stations. Usually means software that emulates RJE stations.

rlogin remote login. Berkeley TCP/IP command to log onto a remote node.

RMS Record Management Services. A common I/O interface for VMS used for access to local data via QIO calls and remote data via the DAP protocol.

root Unix superuser.

routers Dedicated hardware used to route traffic on a network. The alternative is to use a portion of a general purpose system such as a VAX.

RQDX3 DEC controller for the RD series Winchester drives.

RS-232 A physical interface standard, used frequently for connecting asynchronous devices such as terminals.

RSTS Resource Sharing Timesharing System. PDP-based operating system.

RSX Yet another PDP-based operating system. VMS systems running in compatibility mode are able to execute RSX executable images.

RT/PC IBM 32-bit workstation based on a RISC architecture.

SA482 DEC disk cluster with 2.5 GB of capacity.

SASE Specific Application Service Element. Application layer concept in the OSI network architecture. Refers to special purpose services such as the Job Transfer and Manipulation (JTM) facility.

SCA System Communication Architecture. DEC architecture for VAXclusters.

Scriptprinter DEC's Postscript printer.

SCS System Communication Services. Software services used in a VAX Cluster to provide internode communication.

SCSI Small Computer Standard Interface. Pronounced "scuzzy." A standard for connecting disk drives to disk controllers, used typically in small multi-user computers. Third party vendors sell SCSI boards for MicroVAXes.

SDI Standard Disk Interface. DEC's implementation of the Digital Storage Architecture.

SDLC Synchronous Data Link Control. IBM's data link protocol used in SNA networks.

SED Stream Editor. A non-interactive editor on Unix systems particularly useful for very large files and for use in batch jobs.

session Networking term used to refer to the logical stream of data flowing between two programs communicating over a network. Note that there are usually many different sessions originating from one particular node of a network.

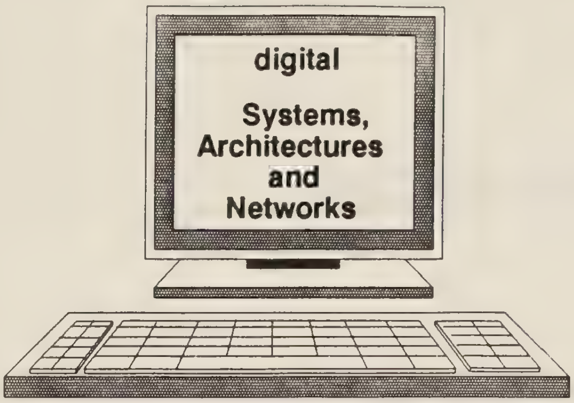
SETPRV A VMS privilege granted in the AUTHORIZE utility which allows the user to obtain any privilege they want.

shell A term that usually refers to the user interface on an operating system. On Unix systems, the C-Shell or the Bourne Shell are primary user interfaces. Contrast with the kernel which interacts with the computer at low levels.

SIG Special Interest Group. Term used to refer to different committees in a user group such as DECUS.

Smartstar A DSRI-compatible application development environment made by Signal Technology.

SMD Storage Module Device. An architecture for storage devices developed by Control Data Corporation and used by several other vendors.



SMP Symmetric Multi Processor. Term used by DEC for true parallel processing in Version V of VMS.

SMTP Simple Mail Transfer Protocol. TCP/IP protocol used on Arpanet for a message handling system.

SNA Systems Network Architecture. IBM's network architecture.

SNADS SNA Distribution Services. An Architecture used for transferring messages in an SNA environment, similar to X.400.

SoftwareAG Maker of DBMS software for VAX and IBM systems.

SPARC Scalable Processor Architecture. A reduced instruction set (RISC) processor developed by Sun and licensed by AT&T. Used in the Sun 4 family of workstations.

splitters A broadband passive componet the divides the signal into two or three paths.

SQL Structured Query Language. ANSI standard data manipulation language used in most relational data base systems.

SSCP System Services Control Point. A network Addressable Unit in IBM's SNA architecture. Resides on a mainframe and is the central point for that domain of an SNA network.

star coupler Device used to connect different nodes of a VAX Cluster that use the CI Bus.

STE Site Termination Equipment. Equipment in an X.25 network that forms the edge of a network. Communication between different X.25 management domains is done between STE's using the X.75 protocols.

Sun Microsystems Manufacturer of Unix-based workstations.

SVID System V Interface Definition. AT&T sponsored definition used to determine the compatibility of different implementations of System V.

Sybase Manufacturer of a hybrid data base system which uses general purpose hardware such as a VAX or Sun Workstation and optimizes it for relational data base operations.

SYS$COMMAND A VMS logical name that points to the device that will be used to input commands for the Digital Command Language. Points to a terminal device for an interactive session or a command file for the current user.

SYS$ERROR A VMS logical name that points to the device used to output error messages for the current user.

SYS$INPUT A VMS logical name that points to the device used to input data (as opposed to commands) for the current user.

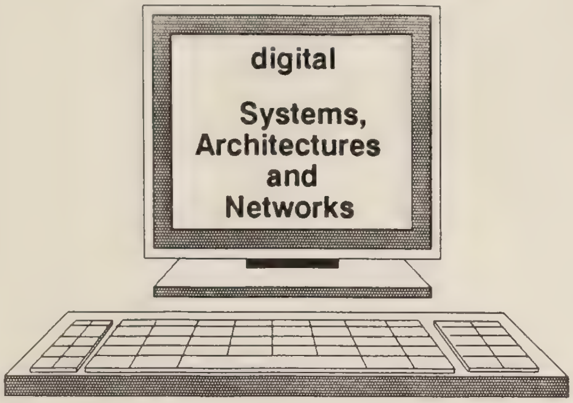
SYS$LOGIN A VMS logical name that points to the default login directory for the current user.

SYS$OUTPUT A VMS logical name that points to the device used to output results (as opposed to errors) for the current user.

SYS$PRINT A VMS logical name that point to the default print queue for the current user.

SYS$SYSTEM A VMS logical name that points to the location of system executable images.

SYSGEN A program in VMS used to alter system-wide parameters such as AWSTIME.



T1 1.544 Mbps communications line provided by long distance common carriers.

taps Attach a broadband drop cable to the trunk cable. The drop cable, in turn, terminates at a device such as a terminal server or workstations.

TCP/IP Transmission Control Protocol/Internet Protocol. Department of Defense sponsored networking protocol, used frequently in Unix environments.

TDMS Terminal Data Management System. DEC forms product, used in conjunction with ACMS.

Teamdata DEC developed user interface for DSRI-compatible relational data bases.

Telenet Packet switched network service offered by GTE.

TELNET Upper layer TCP/IP service for ARPANET implementations. Allows users to log onto remote nodes.

TerraByte One trillion bytes (1,000,000,000,000)

thinwire Thinner, and cheaper, version of Baseband COAX cable used for Ethernet networks. Also called CheaperNet.

tilt A broadban term that describes the difference between insertion losses. Signals at higher frequencies weaken more dramatically than signals at lower frequencies.

Titan A research project by DEC that produced 25 RISC processors.

TK50 DEC tape cartridge which holds 95 MBytes of information.

Token Bus Alternative to Token Ring and Ethernet local area networks. Used in the MAP protocols.

TPU Text Processing Utility. DEC software language used for processing text. Forms the basis for the Language Sensitive Editor (LSE) and the Extensible VAX Editor (EVE).

transceiver A term used in Ethernet networks. The transceiver is the hardware device that connects to the Ethernet media, often a piece of COAX cable. The transceiver is then connected to an Ethernet controller on the host system.

TransLAN A wide area extended Ethernet bridge manufactured by Vitalink.

triggers A data base concept used to implement referential integrity. A trigger is activated when a value is accessed or changed in a particular column or table which then affects other parts of the data base.

trim Term used in forms systems to refer to text that is not part of a field.

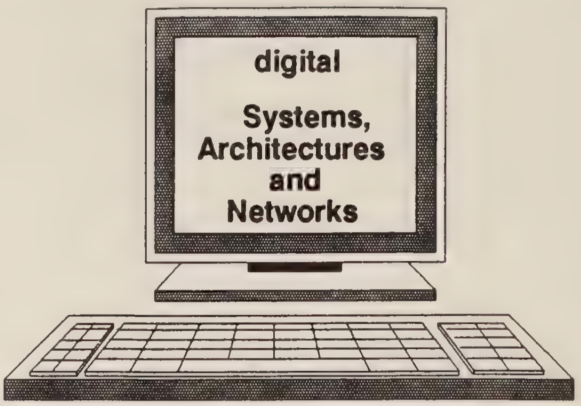
twisted pair A pair of wires (or several pairs of wires) such as those used to connect telephones to distribution panels. Twisted pair is also being used as a physical transmission media for Ethernet, Token Ring and other forms of data links.

Tymnet Public packet switched network based on X.25 owned by McDonnell Douglas.

UAF.DAT User Authorization File on a VMS system. Contains security information for valid system users, including the encrypted password.

UDA50 Unibus disk controller made by DEC compatible with the Digital Storage Architecture.

GLOSSARY



UDP User Datagram Protocol. Used in TCP/IP as an alternative to TCP for unacknowledged datagrams.

UIC User Identification Code. VMS code used to uniquely identify every user on the system. the AUTHORIZE utility to groups of users. Users also have an individual code which is unique within the group.

Ultrix DEC's version of 4.2BSD Unix.

Unibus A peripheral bus used on 11/780 and 8600 VAX processors.

Unify A relational data base management system that runs in Unix environments.

Unix Operating system developed and trademarked by American Telephone and Telegraph. Unix is a pun on the Multics operating system.

Usenet Network of Unix users. This is a somewhat informal network of loosely-coupled nodes that agree to exchange information in the form of electronic mail and a bulletin board.

UUCP Unix to Unix Copy Program. Standard Unix utility used to exchange information between any two Unix nodes. Used as the basis for Usenet.

V.24 A CCITT standard for the physical transfer of data at speeds up to 19.2 Kbps by modem.

VAR Value Added Reseller. Company that embeds another company's products into a more sophisticated product.

VAX Virtual Address Extension. Hardware series made by DEC.

VAX/DBMS CODASYL standard data base product made by DEC.

VAXcluster DEC clusters that operate on the CI bus rather than over the Ethernet.

VAXeln DEC real time operating system.

VAXinfo I A packaged set of VAX Information Architecture products used to develop or prototype simple to mid-range applications. The products are: CCD/Plus, TDMS, DATATREIVE, and Rdb/VMS.

VAXinfo II A packaged set of VAX Information Architecture products used to develop or prototype distributed applications. The products included are: CDD/Plus, TDMS, DATARIEVE, ACMS, Rdb/VMS and Data Distributor.

VAXinfo III A packaged set of VAX Information Architecture products used to develop complex, distributed applications. The products included are: CDD/Plus, TDMS, DATARIEVE, ACMS and DBMS.

VAXmate DEC 80286-based PC/AT clone, with the addition of an Ethernet controller and a different keyboard.

VAXNotes DEC conferencing software.

VAXStations MicroVAX Workstations with a 15 or 19 inch bit-mapped graphic screen and graphics coprocessor.

VI Visual Editor. Full screen editor for 4.2BSD Unix.

VIA VAX Information Architecture. A related set of software systems sold by DEC for data management systems.

VIDA DEC DSRI product that allows access to Cullinet IDMS data bases using any DSRI user interface.

VIFRED Visual Forms Editor. A forms editor made by Relational Technology for the Ingres database system.

Vitalink Makers of the TransLAN wide area Ethernet bridge.

VM Virtual Machine. IBM operating system which permits guest operating systems, such as MVS to reside on top. Usually used in conjunction with the CMS user interface.

VMS Virtual Memory System. DEC proprietary operating system for VAX computers.

VMS/SNA DEC software that allows a VAX with the appropriate synchronous communications board to function as an SNA gateway.

VOTS VAX OSI Transport Services. DEC OSI software that implements layer 4 of the ISO reference model.

VSAM Virtual Sequential Access Method. File organization method used in IBM environments for direct access files. Similar to ISAM (Indexed Sequential Access Method).

VT Virtual Terminal. OSI Application Layer service to allow remote login to other nodes. Also means a series of terminals, such as the DEC VT100 or VT241.

VTAM Virtual Telecommunications Access Method. An IBM software system that provides the interface to an SNA network.

WAN Wide Area Network. Sometimes also used to mean Work Area Network, or a small subnetwork for a work group.

Wollongong Makers of the IP/TCP software for VMS and a Unix emulator for VMS called Eunice.

Word-11 A word processing package that runs on VMS.

WordMarc A word processing package that runs on VMS and DOS operating systems.

WordPerfect A word processing package that runs on VMS and DOS operating systems.

WORM Write Once/Read Many A type of optical disc, contrasted to CD-ROM discs.

WPS/Plus DEC word processing software.

WSDEC Working Set Decrease. A VMS SYSGEN parameter which controls how much memory the AWSA will take away from each process that will have a reduced instruction set.

WSDEFAULT A VMS parameter that controls the size of a user working set.

WSEXTENT A VMS parameter that controls the size of extensions for a user working set.

WSINC Working Set Increase. See WSDEC.

WSQUOTA A VMS parameter that controls the quota of a user working set.

WYSIWYG What You See Is What You Get. Used in office automation to refer to seeing information on the screen the same way it will appear on a final output.

X-OPEN A group that encourages the adoption of selected standards.

X.121 CCITT numbering plan for public data networks.

X.21 CCITT standard for circuit switched networks. Often, a circuit is established using X.21, followed by X.25 traffic over the circuit.

X.25 CCITT standard for packet switched networks.

X.3 CCITT standard for interfacing asynchronous devices to X.25 networks.

X.400 CCITT standard for message handling systems.

X.500 Emerging CCITT standard for directories for X.400 networks.

X.75 CCITT standard for interconnecting separate X.25 networks.

XDR eXternal Data Representation. A machine independent protocol for representing information used in the Network File System (NFS).

Xmodem A set of protocols used for error free file transfer over voice grade lines. Similar to Kermit, Xmodem is used to transfer binary and ASCII files from different hosts that are not running a common set of networking protocols.

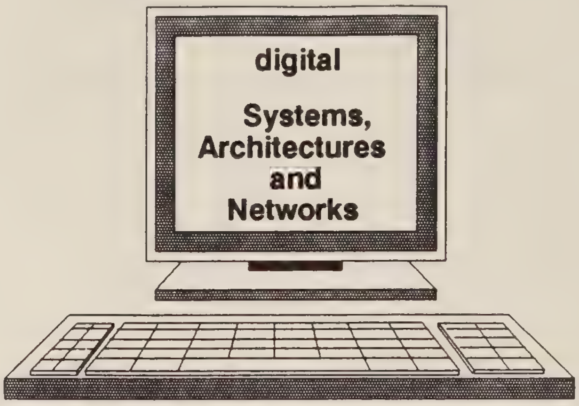
XNS Xerox Network System. A set of upper layer (layers 3 and 4) protocols, typically used in conjunction with Ethernet. An alternative to DECnet or TCP/IP.

YACC Yet Another Compiler Compiler. A Unix parser generator. See LEX.

Yellow Pages A set of services in the Network File System that propagate information out from masters to recipients. Used for the maintenance of system files on complex networks.

Recommended
Reading List

RECOMMENDED READING LIST



CIO
monthly $63/year, free to qualified executives.
The magazine for information executives.

Five Speen Street
Framingham, MA 01701 (508) 872-8200

CommunicationWeek
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The newspaper for the communications industry.

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Suite 650
Los Angeles, CA 90024-2910 (213) 208-1335

Computerworld
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The newsweekly of information systems management.

P.O. Box 2043
Marion, OH 43305 (800) 669-1002

DEC Professional
monthly $30/Year, free to qualified subscribers
An independent magazine covering the DEC world.

P.O. Box 503
Spring House, PA 19477-0503

Data Communications
monthly $33/Year
Magazine for network managers.

P.O. Box 1510
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Digital News
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The newspaper for VAX buyers.

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Digital Review
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InfoWorld
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The weekly for personal computing professionals.

P.O. Box 5994
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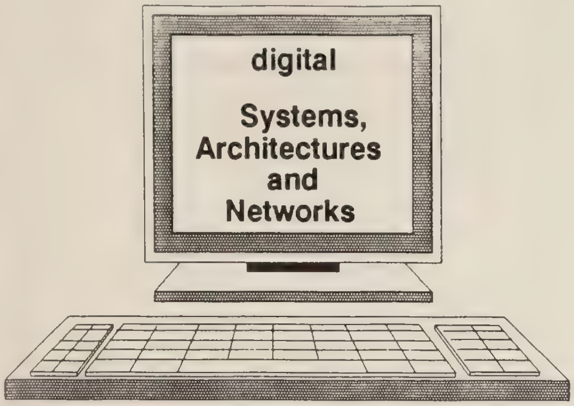

RECOMMENDED READING LIST

LAN
monthly $18/Year
The local area network magazine.

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MISweek
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The newspaper for information management.

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The magazine of Computer-Integrated Manufacturing.

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UNIX Review
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VAX Professional
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The technical journal for VMS Systems.

P.O. Box 504
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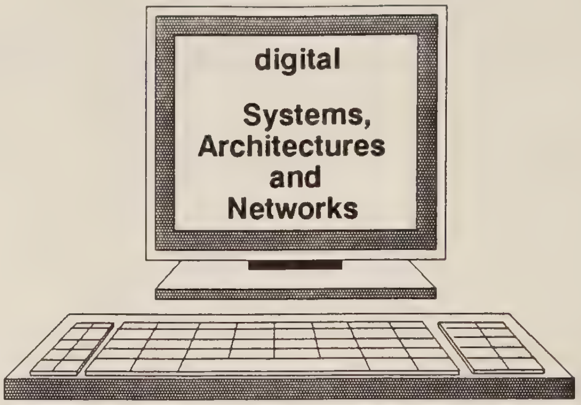
Vendor
Listing

VENDOR LISTING



Access Technology
Two Natick Executive Park
Natick, MA 01760 (508) 655-9191
Makers of 20/20 spreadsheet software.

Advanced Computer Communicatio
720 Santa Barbara Street
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Suite 175
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7401 Boston Boulevard
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CMD Technology, Inc.
3851 S. Main Street
Santa Ana, CA 92707 (714) 549-4422
MSCP compatible disk and tape controllers

CSPI
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Billercia, MA 01821 (617) 272-6020
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Cabletron Industrial Park
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Ethernet products.

Cipher
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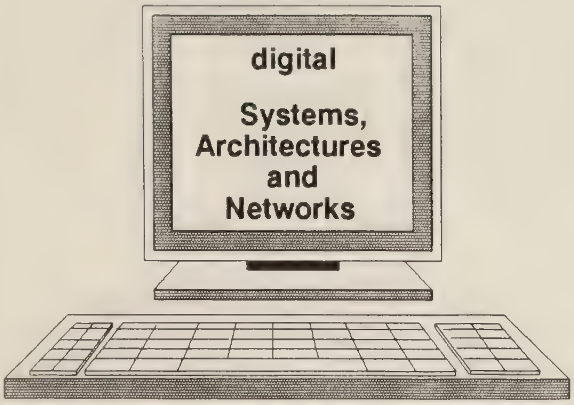
Makers of 1/2" reel-to-reel streaming tape systems.



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Compu-Share, Inc.
5214 68th Street
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Accounting software packages.

Data Management Systems, Inc.
7023 Little River Turnpike
Suite 310
Annandale, VA 22003 (703) 642-2610
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Data Technology Products
P.O. ox 3497
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P.O. Box 6270
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MicroVAX 3500/3600 Enhancements

EMC Corporation
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Hopkinton, MA 01748 (508) 435-1000
Storage and memory upgrade products.

Emulex Corporation
3545 Harbor Blvd.
P.O. Box 6725
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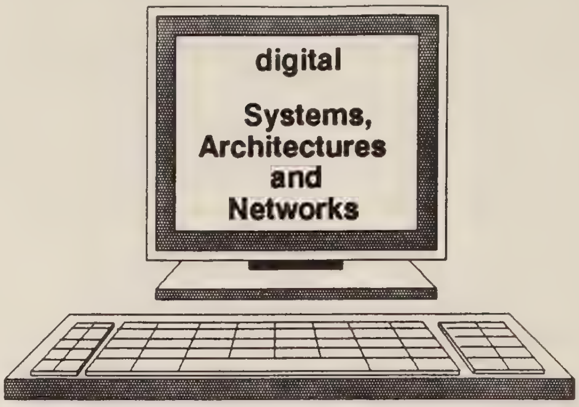
Makers of SCSI host adaptors and other storage controllers.

Equinox, Inc.
14260 S.W. 119 Avenue
Miami, FL 33186 (305) 253-0003
Makers of data switches (DPBS).

Executive Software, Inc.
2219 Broadview
Glendale, CA 91208-9961 (800) 829-4357
Sell disk maintenance software

VENDOR LISTING



Falco Data Products
1294 Hammerwood Ave.
Sunnyvale, CA 94089 (408) 745-7123
DEC compatible terminals.

IBM Corpotation
Old Orchard Road
Armonk, NY 10504 (914) 765-1900
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Information Builders, Inc.
1250 Broadway
New York, NY 10001 (212) 736-4433
Makers of FOCUS database software.

Intel Corporation
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160E Albright Way
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Laser Science Imaging Corp.
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Palo Alto, CA 94306 (800) 835-2400
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MAC-to-VAX software.

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Makers of SmarTerm 240. A DEC VT240/241 terminal emulation package.

Polygon, Inc.
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St. Louis, MO 63141-6304 (314) 576-7709
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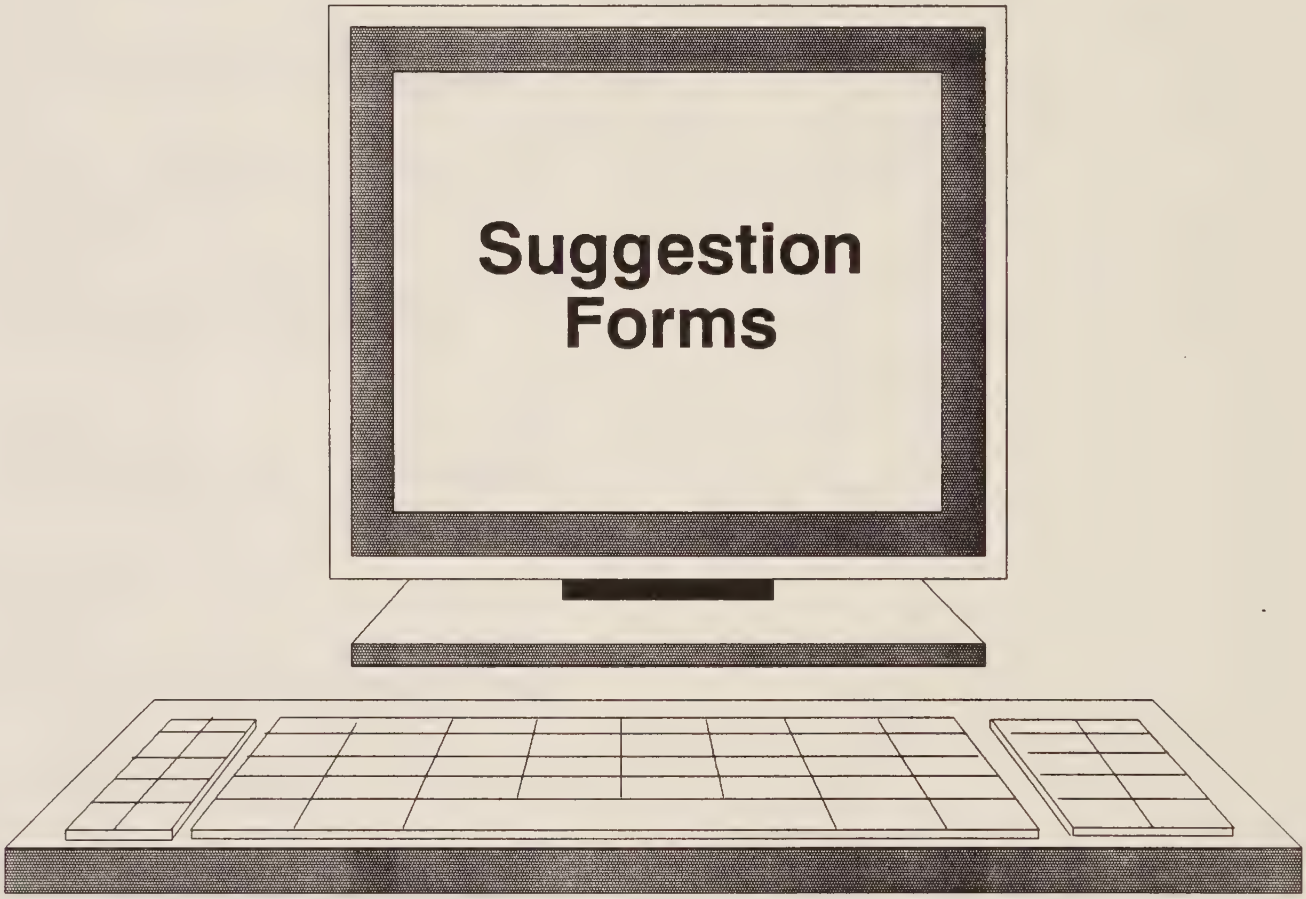
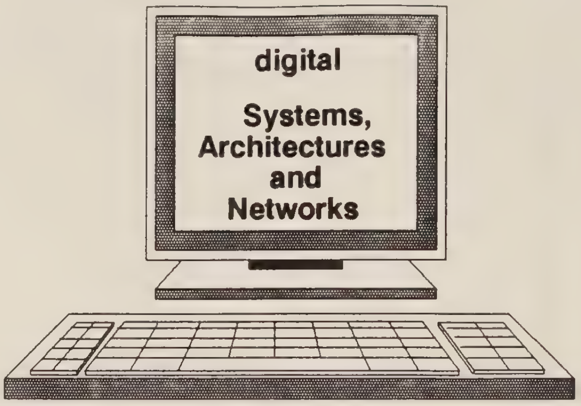


Suggestion Forms

SUGGESTIONS



Suggestion

- Something We Did? ☐
- Something We Didn't Do? ☐

Page Number: ____________

Suggestions: ____

SUGGESTIONS

Suggestion

- **Something We Did?** ☐
- **Something We Didn't Do?** ☐

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Suggestion: ______________________________

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- Something We Didn't Do: ☐

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